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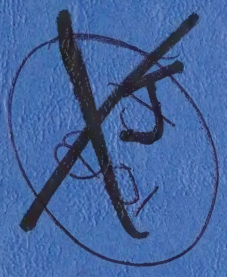
strip chart recorders

VIKING LABORATORIES INC.



series G-2500

INSTRUCTION MANUAL

varian aerograph
2700 mitchell drive/walnut creek/california 94598/415-939-2400
division of varian associates

ADDENDUM TO G-2500 SERIES
INSTRUCTION MANUAL

PUBLICATION No. 85-001070-00

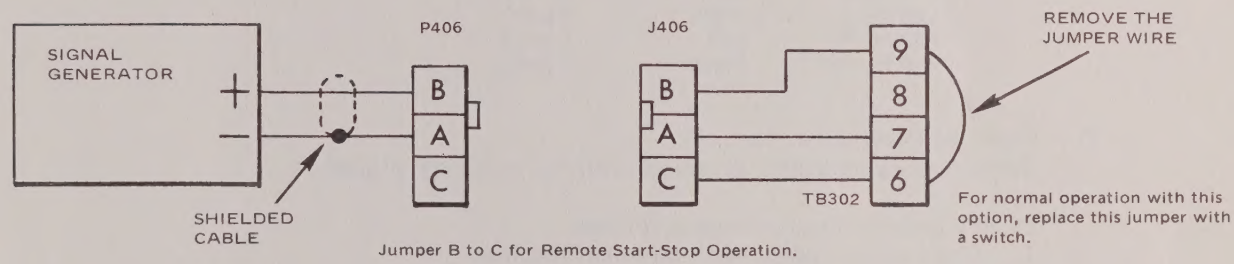
DATE PRINTED: June 1970

Please make the following corrections to your G-2500 Instruction Manual.

1) Page 1-2; under INPUT.
Change +200 to ±200.

2) Page 1-3; under Optional Remote Pen Lift.
Change ". . .between pins P and R. . ." to ". . .between pins K and L. . .".

3) Page 1-3; Figure 1-1.
Change figure as follows:



Jumper B to C for Remote Start-Stop Operation.

4) Page 2-4; under step (7) of paragraph 2.3.2.
Change LEFT-HAND and RIGHT-HAND EVENT MARKER WIRING tables to read as follows:

LEFT-HAND EVENT MARKER WIRING

WIRE COLOR	FROM TERMINAL	TO TERMINAL
gray	2 of TB306	M of J406
blue	3 of TB306	N of J406
white/red	4 of TB306	7 of TB303
white	6 of TB302	R of J406

RIGHT-HAND EVENT MARKER WIRING

WIRE COLOR	FROM TERMINAL	TO TERMINAL
violet	5 of TB306	P of J406
white	6 of TB306	R of J406
white/red	4 of TB306	7 of TB303
white	6 of TB302	R of J406

5) Page 2-4; step (2) of paragraph 2.3.3.
Change step (2) to read as follows:

"Referring to Figure 2-5, solder the leads as follows:

CW	J406-H
CCW	J406-J
Slider	J406-F
Shield	J406-E

6) Page 3-6, Table 3-1.
Change Table 3-1 to read as follows:

TABLE 3-1

MODES OF EVENT MARKER OPERATION

Event Marker	Deflection	Connect Between Pins
Left-hand	Left	S and M
Left-hand	Right	S and N
Right-hand	Left	S and P
Right-hand	Right	S and R

7) Page 4-6; Paragraph 4.7.1.
Delete entire paragraph and replace with the following procedure:

To zero recorder pen, proceed as follows:

1) Short red and black input terminals together.

2) On multiple span recorders, rotate VAR ATTEN control to fully counterclockwise to the CAL position.

3) Set the ZERO control so that the pen is in exact alignment with the desired zero position on the chart paper. With standard polarity circuitry, this is usually near the left-hand margin. With reversed polarity circuitry, the zero position is usually near the right-hand margin of the chart paper.

8) Page 5-2; Digital Chart Drive Assembly Parts List.
Add following items to parts list:

C13, C14, C15 & C16 Capacitor, 0.1 μfd, 50V 05-000236-00

9) Page 5-4; Continuation of Digital Chart Drive Assembly Parts List.
Change description of SCR1 to read:

SCR1 GE C6F Silicon Controlled Rectifier; Part No. 14-000316-00.

10) Page 5-7; Amplifier P.C. Board, R.H. & L.H. Channels.
Add following item to parts list:

C122 Capacitor, 0.022 μfd, 200V 41-724955

11) Page 5-9; Figure 5-4.
Mark C122 on capacitor (drawn on PC board) to left of C106, R107, Q101.

12) Page 5-20; TP-3.
Change 1 msec/cm Horz. to read 2 msec/cm Horz.

13) Page 5-17; Retransmitter Kit.
Change: R304 to R305
R305 to R306.

14) Page 5-6; Miscellaneous Electrical Parts
Add R303 & R304 to parts list.
Resistors R303, R304 are 3Ω, 11 watt, 5% — Part No. 39-000908-00.

G-2500 SERIES
STRIP CHART RECORDERS

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Manufactured in the United States of America

Printed in U.S.A.
June 1970

Publication No.
85-001070-00

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varian aerograph
recorder products

WARRANTY

All instruments and accessories sold by Varian Aerograph are warranted for a period of one year against defects in materials and workmanship. The terms of this warranty are as follows:

1. The warranty period begins with the shipping date of the equipment to the original purchaser.

2. Certain parts such as batteries, fuses, glass accessories, chart paper, vacuum tubes, etc., are expendable in normal use, and their service life is unpredictable. Such expendable items are not covered by this warranty.

3. All requests for service or repair under this warranty must be received within the warranty period by Varian Aerograph or its authorized representative.

4. All repairs, adjustments, and other service under this warranty shall be performed free of charge to the purchaser. However, warranty service and repairs shall be limited to equipment malfunctions which, in the opinion of Varian Aerograph, are due or traceable to defects in original materials or workmanship. Instrument malfunctions caused by abuse or neglect of the equipment are expressly not covered by this warranty.

5. Instrument parts which have been repaired or replaced during the warranty period are themselves warranted only for the remaining unexpired portion of the original one year warranty.

6. Repairs, adjustments, and service performed after expiration of the one year warranty period shall be charged to the purchaser at the then current prices for parts, labor, and transportation.

7. Varian Aerograph expressly disclaims any liability to users of its products for consequential damages of any kind arising out of or connected with the use of its products.

8. Except as stated in Sections 1 through 8 above, Varian Aerograph makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except as stated in Sections 1 through 8 above, Varian Aerograph shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

9. Statements made by any person, including representatives of Varian Aerograph, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Varian Aerograph unless reduced to writing and approved by an officer of the Company.

10. This warranty shall be governed by the laws of California.

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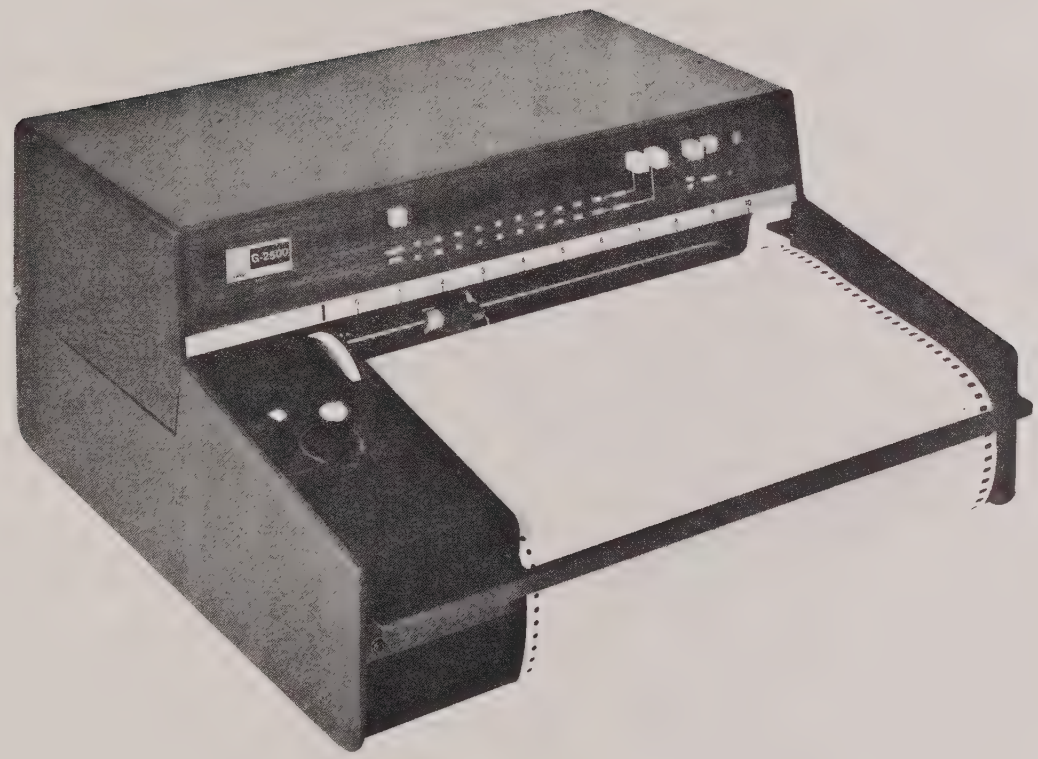


G-2500 STRIP CHART RECORDER

1.1 GENERAL

Varian Series G-2500 ten-inch strip chart recorders are null-balance potentiometric instruments for use with general laboratory equipment. These solid-state recorders are functionally styled to complement the many popular types of modern analytical instruments now in service. The bench-top configuration provides a large number of operator conveniences.

Both single channel and dual channel recorders are offered; three versions of dual channel units are available:

1. Overlapping pens - 3/32 inch maximum offset on time axis; full chart coverage.

2. Crossover pens; same time axis; full chart coverage.

3. Side-by-side pens; same time axis; one-half chart coverage with each pen.

Table 1-1 lists the model numbers for these configurations.

The right-hand channel, facing front of recorder, corresponds to the front pen on dual channel units.

Multiple span G-2500 recorders have a 10-position calibrated span switch with vernier control allowing operator choice of spans from 1 millivolt to 1 volt. With single-span recorders, a plug-in element replaces the 10-position switch.

Each recorder is supplied with a d.c. stepper motor which provides 20 basic chart-drive speeds. Electric pen lift is also a standard.

Other accessories include event markers, retransmitting potentiometers, alarm control switches, and a Z-folded chart paper system, all of which can be either field or factory installed. Accessories which must be factory installed are the Disc integrator and reversed polarity circuitry.

1.2 CONSTRUCTION

The basic recorder is constructed on a heavy duty sheet metal chassis. All mechanical and electromechanical components are mounted on this chassis assembly. The platen, offering ample space for making chart notations, is hinged for easy chart paper loading. A chart paper tear-off bar is mounted across the front of the recorder. The top is hinged and tilts upward to provide quick access to the ink system and the optional integrator switch.

The power switch with indicator light, the chart speed buttons, and the electric pen lift are conveniently located on the main control panel at the tope of the recorder. On multiple span units, the span switch(es) and vernier control(s) are located on the span control panel. Signal input terminals, plug-in single-span element(s) (Models G-25xx), accessory connector, fuse holder, power cord, input connector and calibration controls and adjustments are located at the rear of the chassis.

1.3 SPECIFICATIONS

All specifications apply to line voltage of 105-125V or 210-240V at 50 or 60 ± 2Hz.

TABLE 1-1

RECORDER MODEL CONFIGURATIONS

	One Pen	Two pens Different time axis 10-inch span	Two pens Same time axis 10-inch span	Two pens Same time axis 5-inch span each
Multispan/Single Span Model No.	G-2510	G-2520	G-2522	G-2525

SPAN (Full-Scale Voltage)
10-position, calibrated switch: 1, 2, 5, 10, 20, 50, 100, 200, and 500 mV; 1 volt. Uncalibrated potentiometer for adjustment between spans. Single span, plug-in element optional.

INPUT
Floating, differential; input signal may be +200 Vdc, maximum, from chassis ground.

INPUT RESISTANCE
Potentiometric on 1 mV through 100 mV spans; 1 megohm on 200 mV through 1 volt spans; 50K ohms on uncalibrated spans.

PERMISSIBLE SOURCE RESISTANCE
Up to 50K ohms on calibrated spans.

LINE FREQUENCY REJECTION
Normal Mode (Transverse): 60 db (1000 to 1)
Common Mode (Longitudinal): 140 db (10^7 to 1)

DC REJECTION
140 db or 200 volts, whichever is less.

PEN RESPONSE (50 and 60 Hz)
0.5 second, full scale.

ACCURACY
0.25% of full scale.

SENSITIVITY
0.1% of full scale (10-inch span), or 1 μV, whichever is greater.

REFERENCE VOLTAGE
Electronically regulated (Zener).

ZERO ADJUSTMENT
Full scale.

ZERO SUPPRESSION
One scale width.

DAMPING
Adjustable. Changes in damping do not affect dc calibration.

AMBIENT TEMPERATURE
35° to 110°F.

PAPER (Standard roll chart)
W = 11-5/16 inches; L = 120 feet.

CHART MOTOR SPEEDS
.01, .025, .05, .10, .25, .50, 1.00, 2.50, 5.00, and 10.00 in/min.
1.0, 2.5, 5.0, 10, 25, 50, 100, 250, 500, and 1000 in/hr.

GRID SIZE
10" maximum.

DIMENSIONS
H = 7-1/4"; W = 15-1/2"; D = 15-1/2".

WEIGHT
Single Channel Recorder: 28 lbs. Net; 33 lbs. Shipping.
Dual Channel Recorder: 34 lbs. Net; 39 lbs. Shipping.

POWER REQUIREMENTS
105 to 125 Vac or 210 to 240 Vac; 58 to 62 Hz or 48 to 52 Hz; 46 watts, single channel; 70 watts, dual channel.

1.4 ACCESSORIES AND OPTIONS

• Chart Drive System
The Model 2500 Recorder eliminates the variable speed gearbox and AC motors and allows for variation of chart speeds over three decades.

The basis for this system is a stepping motor which rotates through a specified angle when a pulse is applied in the proper sequence to two of the four windings in the motor. The speed variation is obtained by varying the pulse rate to the motor through the translator circuitry.

• Integrator
An automatic mechanical integrator may be factory-installed on both single and dual channel recorders. This unit, designed by Disc Instruments, Inc., provides an auxiliary pen trace representing the area under the main recorded curve. The integrator pen operates in the right-hand chart margin.

• Event Marker
The timing of significant events can be marked precisely on the chart by using the optional event marker pen. A single or dual action marker pen, with a separate ink supply, can be installed in either chart margin, or in both margins. Operated by positive-acting solenoids and an internal power supply, they require only an external contact closure for actuation. The internal power supply is used for any combination of event markers. Event markers may be either factory or field installed. Refer to paragraph 2.3.2 for field installation instructions and paragraph 3.11.6 for operating instructions. Refer to Table 5-3 for listing of electrical parts.

• Electric Pen Lift
Series G-2500 Recorders have a solenoid-actuated pen lifting mechanism as a standard accessory. The electric pen lift may be operated by means of the PEN UP pushbutton switch on the control panel. The pen is lowered automatically when power is

applied to the recorder. The pen may be raised by pressing the PEN UP pushbutton switch on the control panel. The pen is raised automatically when power is turned off.

• Optional Remote Pen Lift

The pen lift may be operated remotely by making the proper connections between pins P and R of P406. P406 is the multipin mating plug (connector) for receptacle connector J406 which is mounted at the rear of the recorder.

• Alarm/Control Switches

Each recording channel may be equipped with simple auxiliary switches that control low-power external circuits. Contacts can be adjusted to operate at various predetermined points across the width of the recorder scale. Contacts are SPDT, momentary actuation. Voltage rating is 250 Vac, maximum; current rating is 5 A, maximum.

Alarm/control switches may be either factory or field installed. Refer to paragraph 2.3.1 for field installation instructions.

The quantity of alarm/control switches which can be installed is as follows:

Single channel—Up to 6 switches.

Dual channel

Side-by-side pens—Up to 3 switches per channel.

Overlapping or crossover pens—Up to 6 switches on rear channel; none on front channel.

• Z-Folded Chart Paper

Series G-2500 recorders have provision for operation with a convenient type of folded paper which may be used in lieu of conventional roll charts. Each pack consists of a continuous length of paper that is perforated and folded every 8 inches to allow ease of handling and rapid inspection of large amounts of data. Each page in the pack is numbered, and individual sheets can be quickly located and easily removed. Folded packs are available in 200- and 800-sheet sizes. Refer to the Varian Aerograph Supplies Catalog for part numbers and prices. A holder for the folded chart paper, which may be placed under the recorder, is available. Refer to paragraph 2.3.4 for instructions on field installation.

• Retransmitting Potentiometer

Either or both channels can be equipped with a retransmitting potentiometer. It is supplied with a standard feedback potentiometer as an integral unit. Standard resistance is 3K ohms; several nonstandard resistances are also available. The unit may be either factory or field installed. Refer to paragraph 2.3.3 for field installation instructions.

• Reversed Polarity Circuitry

Optional reversed polarity circuitry permits the reversal of zero position on the chart (example: left-hand to right-hand margin) and reverses the direction of pen travel with increasing positive signals. Modification of a recorder from standard to reversed polarity circuitry should be performed at the factory.

• Remote Chart Speed Sweep

The chart paper speed can be changed by varying the frequency of an externally derived signal driving the recorder's clock shaper circuit. This permits a change in chart speed from 0 to 1000 in/hr.

The signal source must be connected to J406 via a connector P406 and shielded cable. The shielded cable is necessary to minimize noise pickup in the cable. Wire signal source to P406 and J406 to TB302 as shown in Figure 1-1. Be sure to remove jumper wire connecting pins 9 and 7 of TB302.

The signal source can be a square, triangle, or sine wave with an amplitude of 10 to 20 Vdc or 8 to 15 Vac. The frequency can be varied from 0 to 100 Hz. On 50 Hz units, use IN/HR speed; 60 Hz units, use IN/MIN.

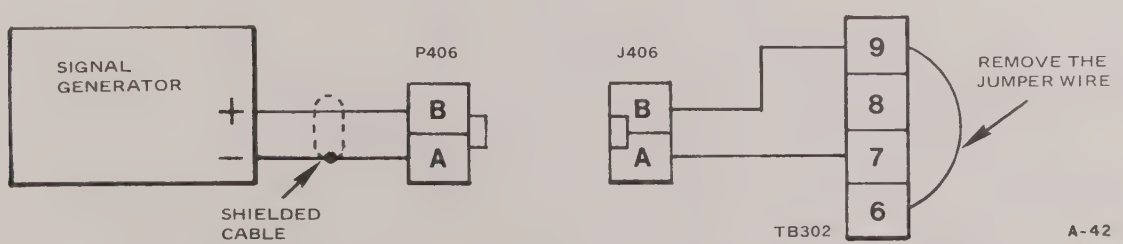


FIGURE 1-1. WIRING DIAGRAM FOR REMOTE SWEEP SPEED CONTROL

1.5 SINGLE SPAN RECORDERS

For applications where a single, fixed span per channel is desired, Models G-25XX offer a plug-in span element mounted at the rear of the recorder. Elements of 10 different voltage spans are standard - others on special order.

Since the span on the dual channel, side-by-side pen system recorder (Model G-2525) is essentially 5 inches for each channel, the elements for this recorder differ from the standard 10-inch span elements. Table 1-2 lists the Varian Aerograph part numbers according to recorder model number.

TABLE 1-2

SPAN ELEMENT - MODEL NUMBER CROSS REFERENCE LIST

	SPAN ELEMENT PART NUMBER	
SPAN	Models G-2510, G2520, G2522	Model G-2525
1 mV	972-261-01	972-261-02
2 mV	972-261-03	972-261-04
5 mV	972-261-05	972-261-06
10 mV	972-261-07	972-261-08
20 mV	972-261-09	972-261-10
50 mV	972-261-11	972-261-12
100 mV	972-261-13	972-261-14
200 mV	972-261-15	972-261-16
500 mV	972-261-17	972-261-18
1 V	972-261-19	972-261-20

2.1 GENERAL

Each Series G-2500 recorder is shipped complete in one commercial-grade shipping container. If the container has been damaged in transit, notation of the damage should be made on the shipping receipt. If the recorder and/or accessory items have been damaged, notify the carrier claim agent. He will provide instructions and forms for reporting and describing the damage.

CAUTION

DO NOT ATTEMPT TO OPERATE DAMAGED EQUIPMENT.

When unpacking the recorder, check carefully to ensure that all components ordered have been supplied. If there are any discrepancies, notify Varian Aerograph, Walnut Creek, Calif., immediately. The packing box should be retained for use should the instrument need to be returned for repair or accessory installation.

After unpacking the recorder, it should be given a visual inspection as outlined below.

2.2 VISUAL INSPECTION

The recorder and accessory items should be visually inspected to assure that no damage to the equipment has occurred in transit. The points to be covered are the following:

1) The pen carriage(s) should move smoothly over the full excursion.

2) All screws should be tightly secured.

3) Make sure all switches operate properly.

4) Turn paper advance thumbwheel at side of the recorder to assure that the sprocket drum turns smoothly.

5) Make sure the correct fuse is properly inserted in its holder.

Correct fuse values are as follows:

Requirement	Recorder	Slo-blo Fuse	VA Part Number
115V, 60 Hz	Single Channel	0.4 amp	19-000042-00
115V, 60 Hz	Dual Channel	0.6 amp	19-000044-00
230V, 50 Hz	Single Channel	0.2 amp	19-000041-00
230V, 50 Hz	Dual Channel	3/8 amp	19-000006-00

When the recorder is ready for operation, proceed to Section 3 - OPERATION. Read all applicable paragraphs of Section 3, install chart paper, pen assemblies, and ink cartridges, and give the recorder an electrical inspection before operating the instrument for the first time.

After it has been determined that the recorder is operating properly, proceed to paragraph 3.10 for detailed operating instructions.

2.3 INSTALLATION OF ACCESSORIES

A power source for all accessories is included as a standard item. This power source is obtained from the Digital chart drive board. Refer to sections on installation procedures for appropriate connection points.

2.3.1 Installation of Alarm/Control Switch(es)

The alarm/control bracket for the rear pen (second channel) is supplied on every recorder. See paragraph 1.4 regarding quantity and location of alarm/control switches. On single channel recorders, however, only the front pen is used, so the alarm/control bracket must be installed.

1) On single channel recorders, mount the alarm/control bracket to the left-hand and right-hand frames with 6-32 screws. Refer to Figure 2-1.

2) Remove the thumb nut from the alarm/control switch.

3) Insert the 4-40 switch stud through the alarm/control bracket from the rear. The ears on the switch engage the slot in the bracket.

4) Replace the thumb nut, but do not tighten.

5) Follow steps (1) through (3) for all switches

being installed.

6) Place the alarm/control switch(es) in desired position(s) and tighten thumb nut(s).

7) Connect the alarm/control switches to connector J406. See wiring diagram (75-000362-00) in Section 6 for proper connections.

2.3.2 Installation of Event Markers

Install left-hand and right-hand event markers as follows:

1) Fasten terminal board TB306 to the side of the recorder using the two screws as shown in Figure 2-2.

2) Place the event marker pen assembly in the location shown in Figure 2-3 and secure to the rear pen alarm/control bracket with two Phillips flat-head No. 4 screws.

NOTE

Figures 2-3 and 2-4 show the left-hand event marker. Install the right-hand event marker using the right-hand mounting holes. Refer to Figure 2-3.

3) Route the wires under the rear pen alarm/control bracket to terminal board TB306. See Figure 2-2.

4) Connect the wires from the left-hand event marker pen assembly as follows:

   a) gray wire to terminal 2 of TB306
   b) blue wire to terminal 3 of TB306
   c) green wire to terminal 4 of TB306

5) Connect the wires from the right-hand event

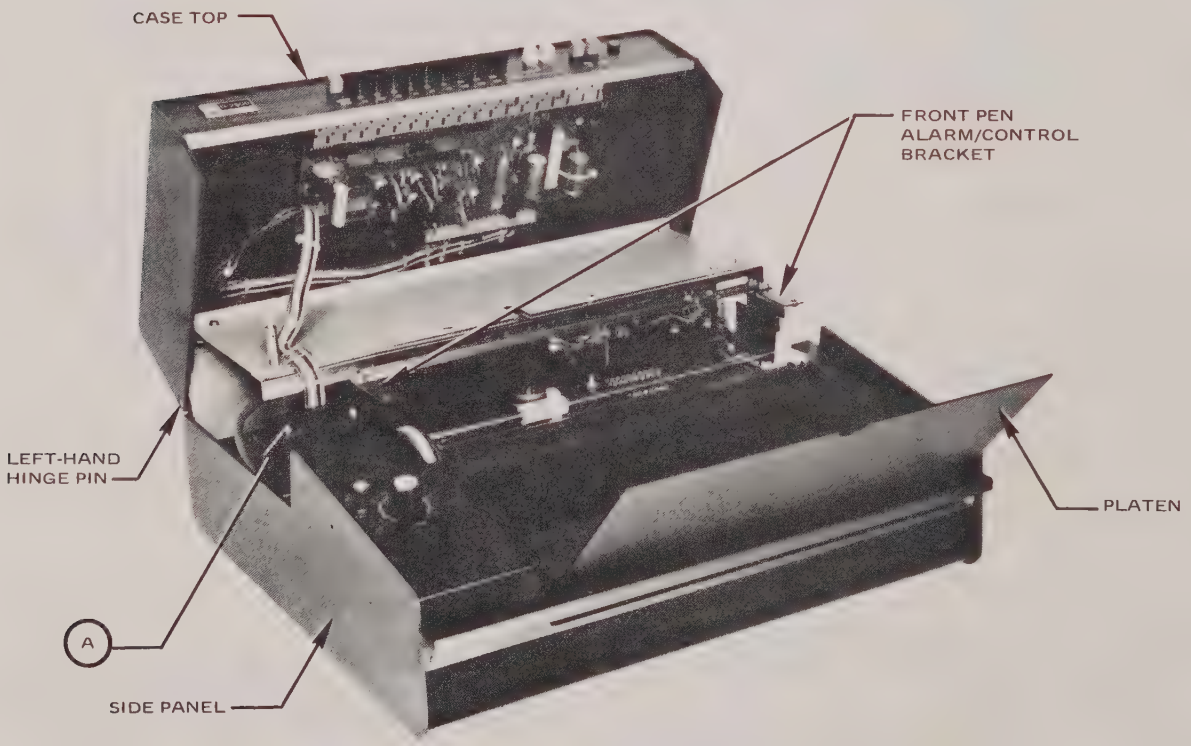


FIGURE 2-1. G-2500 SERIES RECORDER MAJOR COMPONENTS

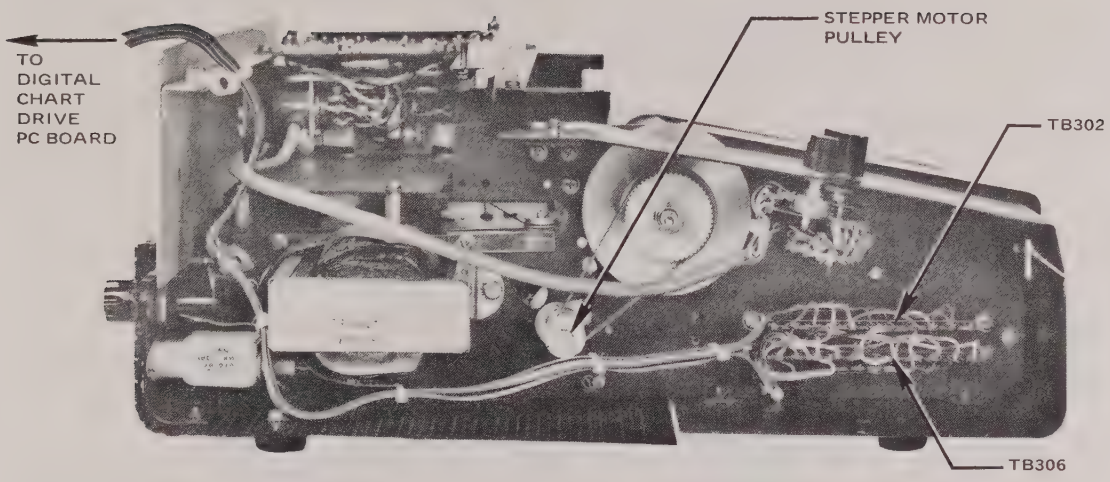


FIGURE 2-2. SIDE VIEW OF RECORDER

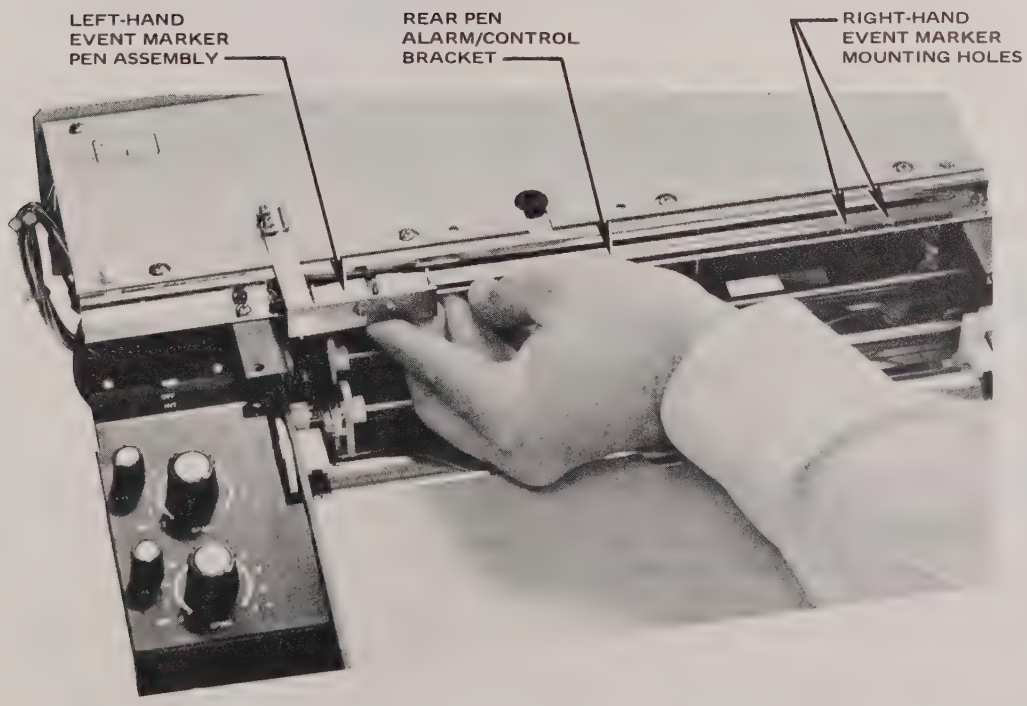


FIGURE 2-3. INSTALLATION OF EVENT MARKER PEN ASSEMBLY

marker pen assembly as follows:

a) green wire to terminal 4 of TB306
b) yellow wire to terminal 5 of TB306
c) white wire to terminal 6 of TB306

6) Connect the red wire from terminal 12 on TB302 to terminal 1 of TB306.

7) Connect the wires from terminal board TB306 to connector J406 and terminal board TB302 as follows:

LEFT-HAND EVENT MARKER WIRING

WIRE COLOR	FROM TERMINAL	TO TERMINAL
yellow/green	1 of TB306	P of J406
gray	2 of TB306	K of J406
blue	3 of TB306	L of J406
white/red	4 of TB306	7 of TB303
white	6 of TB302	R of J406

RIGHT-HAND EVENT MARKER WIRING

WIRE COLOR	FROM TERMINAL	TO TERMINAL
yellow/green	1 of TB306	P of J406
yellow	5 of TB306	M of J406
white	6 of TB306	N of J406
white/red	4 of TB306	7 of TB303
white	6 of TB302	6 of TB305

8) Mount connector J406 to the power bracket using the two slotted screws provided.

Reassemble the recorder as described in the following steps:

9) Insulate the ends of power supply wires which are loose and tie down all wires so they do not interfere with the mechanical operation of the recorder.

10) Replace the side panels on the recorder and hold them in place with the six screws numbered (11) through (16) in Figure 4-4.

11) Replace the bottom screen and fasten with the eight screws numbered (1) through (8) in Figures 4-1 and 4-2.

12) Replace the case top by engaging the left-hand hinge pin, grasping the rear edge of the right-hand side piece, and springing the side piece away from the recorder so it will engage the right-hand hinge pin. See Figure 2-1.

13) Install the event marker pen on the pen assembly. See Figure 2-4.

14) For the left-hand event marker, remove screw A in Figure 2-1 and fasten the ink cartridge clip to the recorder using the nut, bolt, and washer provided in the kit.

15) For the right-hand event marker, use the ink cartridge clip on the pen lift solenoid assembly.

16) Attach one end of capillary ink tubing to the event marker pen assembly and the other end to the pierce and prime unit.

17) Insert the ink cartridge all the way onto the pierce and prime unit. DO NOT SQUEEZE THE CARTRIDGE; apply pressure only at the end opposite the end pierced by the unit. Place the cartridge and pierce and prime unit in the clip.

18) Attach a pen filler to the pen tip and draw on the plunger until ink appears in the pen filler tubing. Remove the pen filler and its tubing.

19) Carefully bend the event marker pen as necessary to align with the recording pen. Also bend the lifting tab as necessary so that the event marker pen lifts when the manual pen lift lever is raised.

20) See paragraph 3.11 for event marker operating instructions.

2.3.3 Installation of Retransmitting Potentiometer
Follow the procedure given in paragraph 4.10 - Potentiometer Replacement. Note in step (9) that the leads disconnected in step (5) are to be connected to the potentiometer next to the servo mounting plate (standard feedback potentiometer). After phasing the feedback potentiometer, proceed as follows:

1) Route the leads from the retransmitting potentiometer to receptacle connector J406 mounted at the rear of the recorder adjacent to the fuse holder.

2) Referring to Figure 2-5, solder the leads to any available pins from A through J on J406.

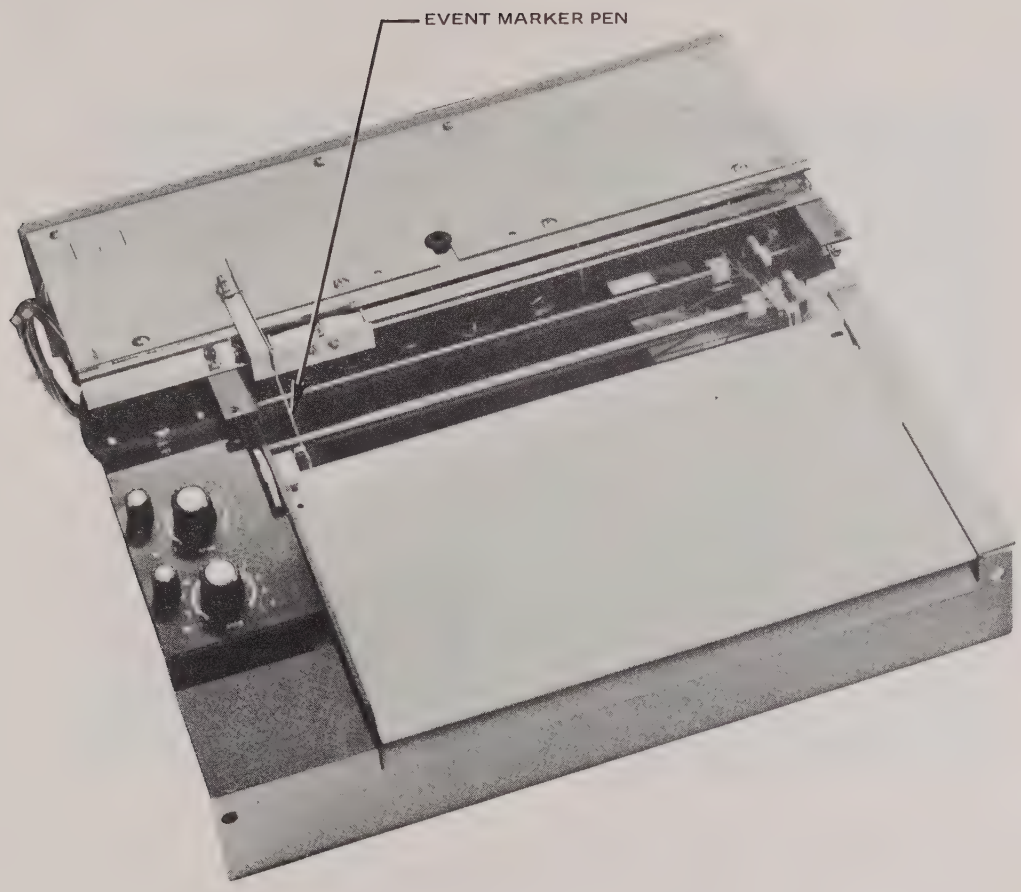


FIGURE 2-4. LOCATION OF EVENT MARKER PEN

3) The retransmitting potentiometer is shipped in phase with the feedback potentiometer. The retransmitter can be rephased by loosening the clamp band between the potentiometer sections and rotating the housing of the retransmitter while holding the feedback potentiometer firmly.

4) Reassemble the recorder, reversing the procedure given in paragraph 4.7.2.

2.3.4 Installation of Z-fold Chart Paper Holder

Remove recorder pen, event marker pen(s), and ink cartridge(s). A package containing two clips will be found in the Z-fold paper holder. These clips are used to keep the recorder in position on the holder. Proceed as follows:

1) Turn the recorder onto its left-hand side. Referring to Figure 4-4, remove screw No (15). Mount one clip in this position so the tab faces the front, outside edge of the recorder. Insert the screw through the hole in the clip which is closer to the tab and tighten the screw.

2) Referring to Figure 4-4, remove screw No (1). Retain the lock washer but discard the flat washer under the screw. Mount the other clip in this position so the tab faces the rear, outside of the recorder. Insert the screw through the hole in the clip which is farther from the tab, then through the lockwasher, and tighten the screw.

3) Place the recorder on the Z-fold holder so that the side frames of the recorder are positioned outside the rails on the holder. The

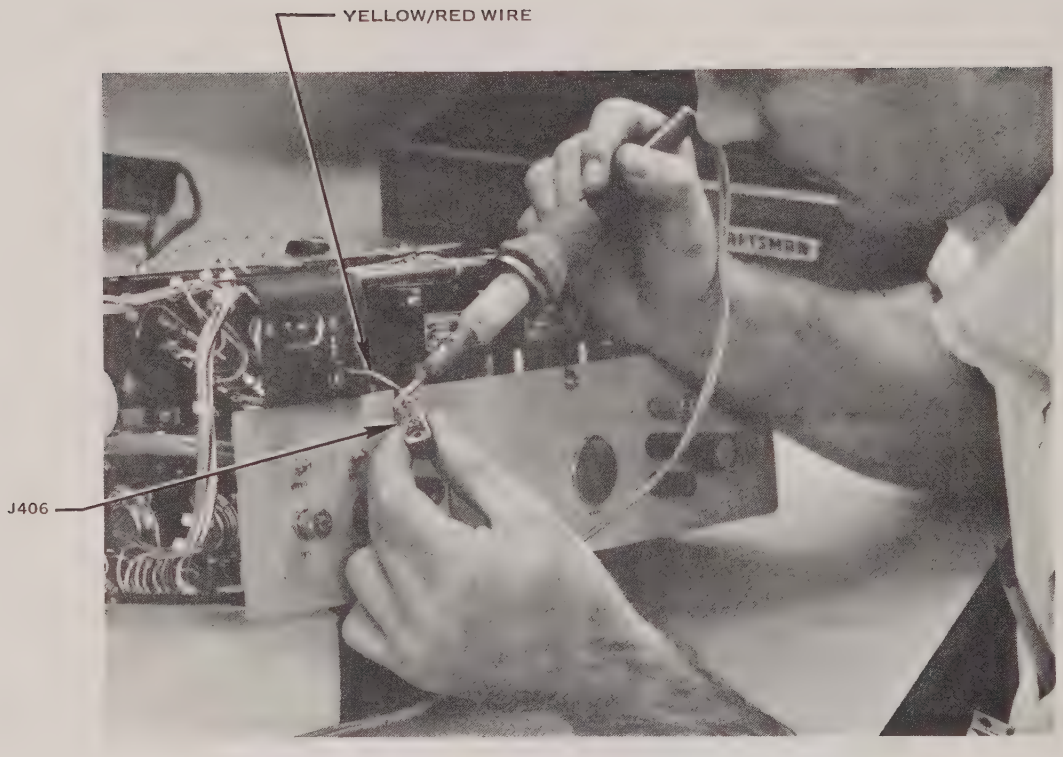


FIGURE 2-5. CONNECTING WIRES TO J406

clips attached in steps (1) and (2) will prevent the recorder from sliding off the holder.

4) Place the chart paper in the removable tray inside the Z-fold holder. The top sheet of the chart paper should read "199 sheets left" (or "799 sheets left") and the round sprocket holes should be at the left.

5) Place the end of the chart paper under the tear-off bar and under the platen. Raise the platen and insert the end of the chart paper under the sprocket drum, aligning the sprocket holes with sprockets on the drum.

6) Raise the paper hold-down clips, lower the platen, and rotate the paper advance thumbwheel to bring the paper over the platen.

7) Lower the paper hold-down clips.

8) Push the tray containing the paper to the rear of the Z-fold holder so that 7 inches remains at the front of the holder to collect the recorded chart.

9) Push the drawer into the Z-fold holder until a ½-inch gap remains between the top of the tray and the holder.

10) Advance the chart over the tear-off bar and check that the paper withdraws smoothly from the tray and stacks properly in the holder.

3.1 GENERAL

All operating controls and adjustments are located on the control panels or at the rear of the recorder. Both chart paper loading and ink cartridge installation are simple procedures. Standard chart paper comes in rolls approximately 120-feet long. The number of feet remaining in the roll is normally marked at one foot intervals on the left-hand margin of the paper. A specially formulated ink comes in cartridge form.

3.2 INSTALLATION OF CHART PAPER

Install chart paper as follows:

1) Raise the platen and place a roll of chart paper on the flat portion of the paper chute so that the roll rests against the under side of the platen. Be sure that the round sprocket holes are at the left, and oblong holes are at the right.

2) Holding the roll in place, unwind about 8 inches of paper.

3) Feed the end of the paper under the sprocket drum. Turn the thumbwheel towards you to pull the chart paper around the sprocket drum. Be sure the holes at either side of the chart paper are engaged with sprockets and that the paper is properly aligned.

4) Place the roll in the paper chute and lower the platen.

5) Using the thumbwheel, advance the chart paper over the platen and feed the paper through the slot between the platen and the paper tear bar.

6) Attach the chart-weight clip to the end of the chart paper at its center.

3.3 INSTALLATION OF PEN ASSEMBLY AND INK CARTRIDGE - MAIN RECORDER PEN(S)

Install pen assembly and ink cartridge as follows:

1) As an aid to installing an ink cartridge, the indented end of the cartridge may be carefully pre-punched with a sharp object. This procedure is optional.

2) Holding the pen assembly in its normal upright position (do not cover the vent tube with finger), insert the ink cartridge all the way onto the pen assembly. DO NOT SQUEEZE THE CARTRIDGE; apply pressure only at the end opposite the end pierced by the pen.

3) Clip the pen assembly over the pen bearing. Be sure the guide pin engages the slot in the pen bearing. For correct pen alignment, push the pen assembly snug against the stop at the right-hand side of the pen bearing.

4) With plastic tubing supplied, attach a pen filler to the pen tip and draw on the plunger until ink barely appears in the tubing. Remove the pen filler and tubing.

5) To remove the pen assembly (for replacement of the ink cartridge), simply slide the assembly off the left-hand end of the pen bearing.

3.4 INSTALLATION OF INK CARTRIDGES - EVENT MARKER PEN(S)

Follow steps (16), (17), and (18) of paragraph 2.3.2.

3.5 PRIMARY POWER REQUIREMENTS

Recorders are shipped ready for operation from a primary power source of 115 or 230 V ac, 60 or 50 Hz. Each recorder comes equipped with a 3-conductor power cable terminated with a standard power plug. A plate mounted on the rear of the recorder indicates power specifications for the recorder.

3.6 SIGNAL SOURCE CONNECTIONS

The red, black, and silver binding posts at the rear of the recorder are used to connect signal voltages to be monitored. The red post is the high potential (+) terminal, the black post is the low potential (-) or signal ground terminal, and the silver post is the chassis ground terminal. These terminals should be used as required by the circuit configuration that produces the voltage to be monitored. Under stan-

dard polarity conditions, a positive-going signal applied to the red binding post will move the pen from left to right. See paragraph 1.4 for information on reversed polarity circuitry.

3.7 CONTROLS AND CALIBRATION ADJUSTMENTS

The following paragraphs describe the controls and calibration adjustments found on the G-2500 Recorder. Refer to Figures 3-1 and 3-2 for location of the following controls.

• POWER Pushbutton Switch
The POWER switch (ON-OFF), located on the control panel, controls ac power to the recorder. In the ON position (pushed in), the indicator lamp will light, the servo amplifier(s) will operate and the pen(s) will respond to input signals. A short time will be required before the power supply voltages stabilize. In the OFF position, the power switch removes power from the recorder.

• Chart Drive Control
The chart drive controls are located on the main control panel. To select the desired speed, simply push the IN/HR or IN/MIN pushbutton switch for desired chart speed and then select the pushbutton switch corresponding to the desired speed, i.e., 1.0 2.5, 10, etc., IN/HR. To stop the chart advance, push the CHART STOP pushbutton switch. The light adjacent to the CHART STOP pushbutton switch indicates when the chart is advancing.

The chart advance thumbwheel located at the left-hand side of the recorder allows quick chart advancement. The chart advance thumbwheel may be rotated manually at any time without damage to the recorder's mechanical system.

The OFF - ON switch (refer to Figure 4-7 for location of switch) for the optional integrator is connected so that the integrator may be operated at any speed setting or turned off completely.

• SPAN Control
Multiple span recorders have 10-position rotary switches for selection of the desired span. Calibrated spans are 1, 2, 5, 10, 20, 50, 100, 200, 500 millivolts, and 1 volt. The variable attenuator (VAR ATTEN) control, located adjacent to the SPAN switch, operates switch S502 and variable resistor R505. Switch S502 is open in the CCW position (CAL) of the control; R505 provides con-

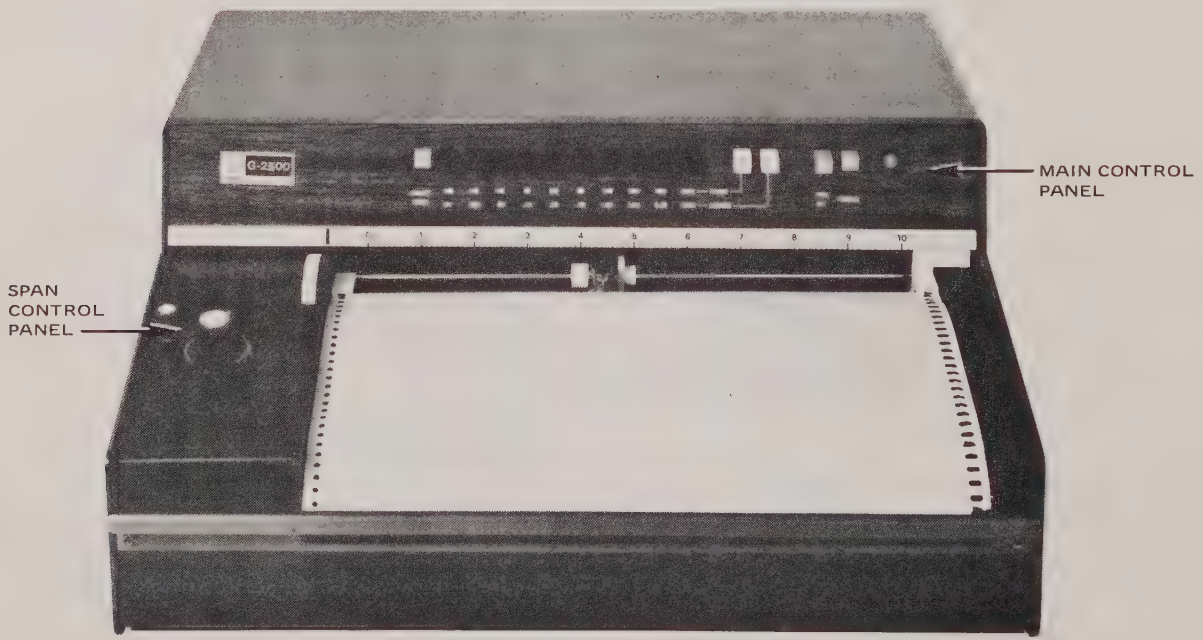


FIGURE 3-1. RECORDER FRONT PANEL

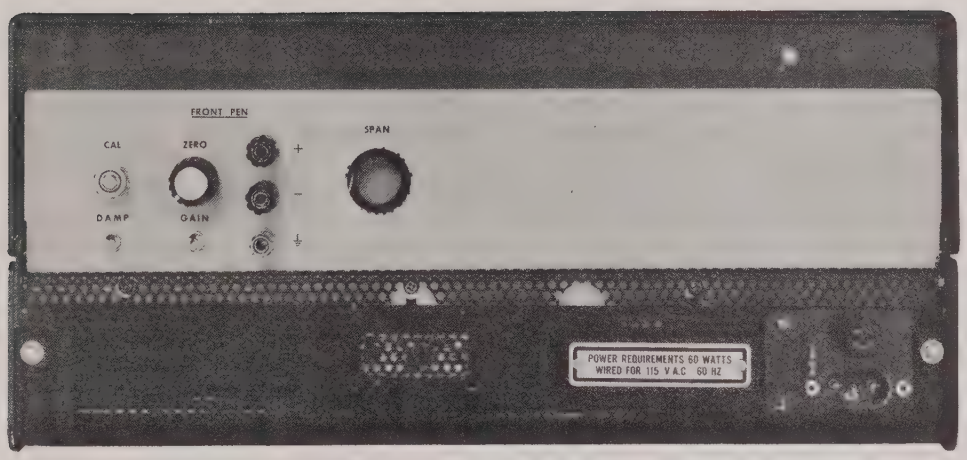


FIGURE 3-2. RECORDER REAR PANEL

tinuous adjustment of input signal level from 100% to 20% of the full scale value selected by the SPAN switch when S502 is closed.

The span element on single-span recorders may be exchanged for another element simply by withdrawing the unit and inserting the other element. If necessary, the procedures given in paragraph 4.7 may be followed to calibrate the recorder for the new span value.

• Zero Adjustment
The ZERO control is located at the rear of the recorder. This control permits the operator to position the pen tip precisely at the desired zero position on the chart when the signal input terminals are shorted together. Full scale zero adjustment and one full scale width of zero suppression are provided on Series G-2500 recorders.

• Calibration Adjustments
Damping (DAMP), gain (GAIN), and calibration (CAL) adjustments are located at the rear of the recorder and need no adjustment during normal operation.

3.8 MODES OF OPERATION

The following paragraphs describe the various modes of operation for the G-2500 Recorders.

3.8.1 Single Channel Recorders

The various calibration adjustments of the recorder can be set as detailed in paragraph 4.7 to obtain the 1) left margin zero, 2) right margin zero, 3) displaced zero, or 4) suppressed zero mode of operation described below. Note that when an integrator is installed, 0.8 inch of the 10-inch chart is required for the right-hand margin integrator trace.

• Left Margin Zero Mode
In the left margin zero mode of operation, the ZERO control is set so that the pen is positioned over the left margin of the chart paper when the signal input terminals are shorted. The pen is driven toward the right margin when a positive dc input signal voltage is applied. The adjustment can be set so that the right margin represents a voltage between 1 millivolt and 1 volt, depending on the span selected. The linear scale across the top of the recorder can be used to determine the value of

each intermediate point on the chart paper when the left margin represents zero volts and the right margin represents some voltage between 1 millivolt and 1 volt.

• **Right Margin Zero Mode**
In the right margin zero mode of operation, the ZERO control is set so that the pen is positioned over the right margin of the chart paper when the signal input terminals are shorted. The pen is driven toward the left margin when a negative dc input signal voltage is applied. The adjustment can be set so that the left margin represents a voltage between 1 millivolt and 1 volt, depending on the span selected. The linear scale across the top of the recorder can be used to determine the value of each intermediate point on the chart paper when the right margin represents zero volts and the left margin represents some voltage between 1 millivolt and 1 volt.

With reversed polarity circuitry (see paragraph 1.4), positive dc voltages will drive the pen to the left.

• **Displaced Zero Mode**
The ZERO control can be set so that any point on the chart paper represents zero signal voltage. If any point except the left or right margin is used, the recorder is considered to be in a displaced zero mode of operation. In this mode, a positive input voltage drives the pen to the right and a negative input voltage drives the pen to the left. The VAR ATTEN control can be set so that the numerical (not algebraic) sum of the voltages is equal to the full scale voltage selected. The linear scale across the top of the recorder can be used to determine the value of each point on the chart paper.

For example: If the zero adjustment is set so that the pen comes to rest at the numeral 4 on a 0-10 scale with zero signal volts applied and at the numeral 10 with 6 millivolts applied, an input signal that drives the pen to the numeral 2 has a negative polarity and an amplitude of 2 millivolts.

• **Suppressed Zero Mode**
In the suppressed zero mode, no point on the chart paper represents zero input signal. The left- and right-hand margins both represent voltages of a positive polarity that differ in amplitude. The difference in amplitude is determined by the setting of the CAL adjustment.

For example: If the procedure in paragraphs 4.7.1 through 4.7.3 were followed so that the left margin represented zero signal and the right margin represented +50 millivolts, the procedure in paragraph 4.7.5 could be used to make the left margin represent +20 millivolts. This would automatically make the right margin represent +70 millivolts. Note that these procedures apply only to positive voltages and that the span remains the same (50 millivolts) but the end points are shifted (from zero to +20 millivolts and +50 to +70 millivolts) an equal amount in the same direction.

3.8.2 Dual Channel Recorders
Any of the modes of operation described under paragraph 3.8.1 can be applied to both pens in dual channel recorders. Note that with the side-by-side pen system, the span for each channel is essentially 5 inches. When an integrator is installed, 0.8 inch of right-hand chart margin is required for the integrator trace.

3.9 ELECTRICAL INSPECTION

The following instructions should be followed for single channel recorders and for **both** channels of dual channel recorders. If an electrical or mechanical failure occurs during this inspection, refer to paragraph 4.6 and perform a detailed physical inspection of the recorder as follows:

1) Turn POWER switch to OFF.

2) Turn CHART switch to OFF.

3) Install a roll of chart paper. See paragraph 3.2

4) Install pen assembly and ink cartridge. See paragraph 3.3.

5) BE SURE THE RECORDER AND ANY AUXILIARY EQUIPMENT ARE CONNECTED TO EARTH GROUND. The ground wire of the 3-wire power cord and the silver binding post(s) (chassis ground) are internally connected. Thus, a 3-wire power cord automatically connects the recorder to earth ground when plugged into a grounded 3-wire power system. However, in the absence of this type of system, the recorder chassis and any auxiliary equipment MUST be connected to earth ground by means of an additional wire.

6) Short the red (+) and black (-) signal input terminals together.

7) On multiple span recorders, rotate the SPAN switch fully CW to the 1 volt position and the VAR ATTEN switch fully CCW to the CAL position, checking that both switches operate properly.

8) Connect the power cord to a proper source of power.

9) Turn the POWER switch to ON and observe that the indicator lamp is lit.

NOTE

If the indicator lamp does not light, check the fuse at the rear of the recorder and replace if necessary.

The pen will not respond instantaneously when the POWER switch is turned ON. Approximately 5 to 10 seconds are required for the amplifier voltages to stabilize and produce pen movement.

10) Rotate the ZERO control until the pen tip is aligned with the point on the chart paper that is to represent zero input signal.

11) Test all positions of the chart drive control by using all of the available pushbutton switches. Check both the IN/HR and IN/MIN ranges. Also, check chart STOP-START with appropriate switches.

12) On multiple span recorders, rotate the SPAN switch to any desired setting.

13) Remove the short from the signal input terminals. Connect a dc voltage between the same terminals corresponding to the SPAN switch setting, or, with single-span recorders, to the voltage rating of the plug-in element. Observe that the pen moves to the point on the chart paper that represents the full scale voltage value.

14) Remove the dc voltage from the signal input terminals. Short these terminals and observe that the pen returns to the zero input signal position.

NOTE

The recorder is completely calibrated before shipment in accordance with the requirements specified. The calibration can be checked or changed as described in paragraph 4.7 of this manual.

15) Press chart STOP pushbutton switch.

3.10 RECORDER OPERATION

Referring to Figure 3-1, operate recorder as follows:

1) Check supply of chart paper and ink.

2) Connect the power cord to an ac power source. BE SURE THE RECORDER IS PROPERLY GROUNDED. See Step 5, paragraph 3.9.

3) Turn the POWER switch ON. The pen will not respond instantaneously when the POWER switch is turned ON. Approximately 5 to 10 seconds are required for the amplifier voltages to stabilize and produce pen movement.

4) Short the red (+) and black (-) input terminals together.

5) Using the ZERO control, place the pen(s) at the desired position(s).

6) On multiple span recorders, set the SPAN switch and the VAR ATTEN control in positions corresponding to the maximum voltage to be monitored.

7) On single-span recorders, check that the rating of the plug-in element corresponds to the maximum voltage to be monitored.

8) Remove the short across the input terminals and apply the input signal to be monitored.

9) Select the chart speed desired by pressing appropriate CHART SPEED (IN/HR or IN/MIN) pushbutton switch.

10) To tear off chart paper, pull upward on the paper using the paper tear bar as a knife edge.

3.11 EVENT MARKER OPERATION

To operate event markers, an external contact closure must be provided between designated pins on plug connector P406, the multipin mating connector for receptacle connector J406 mounted on the rear of the recorder. See the Wiring Diagram in Section 6. The correct connections for the four modes of event marker operation are shown in Table 3-1.

TABLE 3-1

MODES OF EVENT MARKER OPERATION

Event Marker	Deflection	Connect Between Pins
Left-hand	Left	P and K
Left-hand	Right	P and L
Right-hand	Left	P and M
Right-hand	Right	P and N

3.12 OPERATING REMARKS AND RECOMMENDATIONS

The presence of voltages of power-line frequency at the recorder input may result in impaired recorder performance. The following describes one method of reducing the effects of ac voltage at the input.

AC voltages may be picked up by wires connecting the input signal source to the recorder, especially if the signal source has high internal resistance. These undesirable ac voltages may be eliminated by using shielded wires to connect the input signal source to the recorder. If shielded wires are used, the shield should be grounded only at the ground terminal of the recorder. Grounding both ends of the shield can produce ground loops. Most low resistance sources will not require shielding. Simple twisted-pair leads will usually be satisfactory.

Series G-2500 recorders may be operated with a steady dc potential of ±200 volts maximum between chassis ground and the input signal.

4.1 GENERAL

Service and maintenance of Series G-2500 recorders should be performed only be persons experienced in servicing electromechanical devices having transistorized circuitry. If no such person is available, the recorder should be sent to the factory, or to a factory representative, for service.

4.2 FIELD AND FACTORY SERVICE

Please get in touch with the Recorder Products Service Manager prior to returning any equipment to the factory, to determine the service needed. Should it become necessary to return an instrument for service, please observe the following:

1) Remove pens, ink cartridges, chart paper, dust cover, and power cord; do not send with equipment.

2) Rinse out any capillary tubing with water.

3) The original shipping container or another suitable container should be used and the recorder should be surrounded on all six sides by about 4 inches of packing material.

4) Recorders should be shipped by Railway Express, air freight, or motor freight, PREPAID, to the nearest Varian Aerograph Recorder Sales Representative, or to:

Varian Aerograph
2700 Mitchell Drive
Walnut Creek, California 94598

Attention: Recorder Products
Service Manager

5) Each recorder should be accompanied by a full description of difficulties encountered, model and serial number of recorder, date of purchase, and name of representative from whom the recorder was purchased.

NOTE

Varian Aerograph has an established policy that equipment sent in for service will be completely checked in addition to correcting the cause of the malfunction. Equipment returned to the user will meet the specifications under which it was originally sold. When it appears that it will be unusually expensive to bring an out of warranty instrument up to specifications, the user will be contacted for specific instructions.

4.3 PREVENTIVE MAINTENANCE

• Pens
Recorder pens must be kept clean for proper functioning. Inks are water-soluble. For cleaning, water should be forced through the pen system. Cold water is normally satisfactory; however, if the pen is obstructed, liquid detergent in warm water may be used and a piece of pen cleaning wire may be drawn through the pen system to dislodge the obstruction. The pen filler furnished with the recorder may be used as an aid in cleaning the pen. A small piece of plastic tubing installed between the pen filler and the pen tip may be used as a connection when drawing or feeding water through the pen. To assure maximum performance, pens should always be cleaned immediately after use.

• Carriage Rods
To maintain smooth operation of the pen carriage(s), the carriage rods must be kept clean. Be sure to clean the rod if ink should accidently be spilled onto it. Periodically, clean the carriage rods with a dry, lint-free cloth. DO NOT OIL THESE RODS.

4.4 LUBRICATION

Only the servo motor(s) in Series G-2500 recorders require lubrication, at three month intervals. Place *one* or *two* drops of motor oil (furnished with the recorder) in each of the red-painted holes in the servo motor(s). DO NOT OVER-LUBRICATE. A pen filler can be used for transferring the oil. The tip of the pen filler is inserted through convenient holes in the rear screen.

4.5 TROUBLESHOOTING

If the recorder does not function properly, read Section 3 of this manual carefully. Determine that

1) the chart paper and ink were properly installed, 2) the recorder is connected to a proper source of primary power, 3) the signal inputs are properly connected to the recorder, and 4) the operating controls are in appropriate positions. Schematics and Wiring Diagram in Section 6 can be used as guides while troubleshooting.

4.5.1 Physical Inspection

Disassemble the recorder following the procedure given in paragraph 4.6. Thoroughly inspect the recorder. Among the points to be covered are the following:

1) Check that all assemblies and components are securely mounted.

2) Check that all connections to terminal boards, connectors, etc., are securely fastened.

3) Check pen drive cabling for smooth operation.

4.5.2 Troubleshooting Chart

Table 4-1 lists symptoms and possible causes of recorder malfunction:

TABLE 4-1

TROUBLESHOOTING CHART

Symptom	Possible Cause
Recorder fails to operate	Power cord not connected. Fuse open.
Chart paper does not advance.	Fuse open (fuse located on Digital Drive Board).
Pen moves to extreme limit of travel; servo motor continues to operate.	Chopper defective. Input circuit open.
Large dead band; sluggish operation.	Low amplifier gain. Stray ac pickup. Excessive source resistance. Low line voltage. Chopper defective. Bind in mechanical system. Excessive drive cable tension. Zener diodes defective.
Nonuniform pen velocity.	Bind in mechanical system (pen carriage binding on rod). Excessive drive cable slack. Chopper defective.
Pen oscillates at any position of DAMP control.	Excessive amplifier gain. Dirty potentiometer. Open damping control.
Repeated pen "jitter" at same point on chart.	Dirty or worn feedback potentiometer.
Intermittent pen oscillation at various points on chart.	Power line transients. Loose connection of signal cable.
Low or zero gain.	Defective transistor. Power supply defective.
Steady pen deflection to right or left.	Chopper defective (bad contacts). Input circuit open.
No servo control; no signal response.	Chopper defective (open winding).
Erratic pen movement.	Feedback potentiometer defective. Power supply capacitors defective.
Loss of reference or amplifier supply voltage.	Zener diodes defective. Power supply defective.
Full span sweep across chart is curved or irregular.	Bind in mechanical system. Shorted potentiometer windings.
Loss of calibration.	Zener diode defective.

4.6 DISASSEMBLY

The following paragraphs outline partial and complete disassembly procedures.

• Partial Disassembly

To disassemble the recorder for only amplifier servicing and/or restringing pen drive cable, proceed as follows. Be sure the power cord, accessory plug, and signal leads are disconnected.

1) Remove pen(s), ink cartridge(s), and chart paper.

2) To remove case top, tilt top upward; then, grasp top at the right-hand rear edge and spring the side piece out to the right, disengaging it from the hinge pin. Now, move top to the left, and disengage from the left-hand hinge pin.

3) Turn the recorder around so you are facing the rear of the recorder. With a Phillips screwdriver, loosen (do not remove) the three screws along the bottom of the input panel by inserting the screwdriver through the holes provided in the rear screen. See Figure 4-1 for location of screws.

4) Remove the two screws at either end of the rear alarm/control bracket. See Figure 2-1.

5) Unplug connector(s) from the amplifier printed circuit board(s). See Figure 4-2.

6) Unplug connector attached to the chart drive P.C. Board located under the top cover. See Figure 4-3.

7) Lift the amplifier and rear panel assembly free of the recorder. The amplifier is now available for servicing.

WARNING

Use extreme caution while performing maintenance on a disassembled recorder since primary power switch terminals are exposed.

8) On dual channel recorders, remove the four

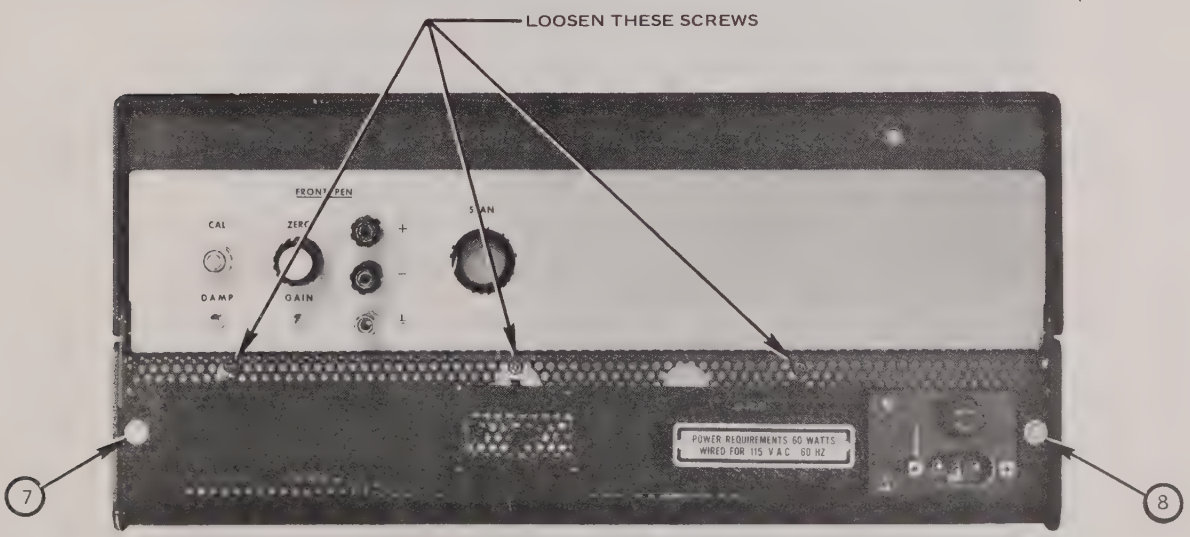


FIGURE 4-1. LOCATION OF REAR PANEL MOUNTING SCREWS

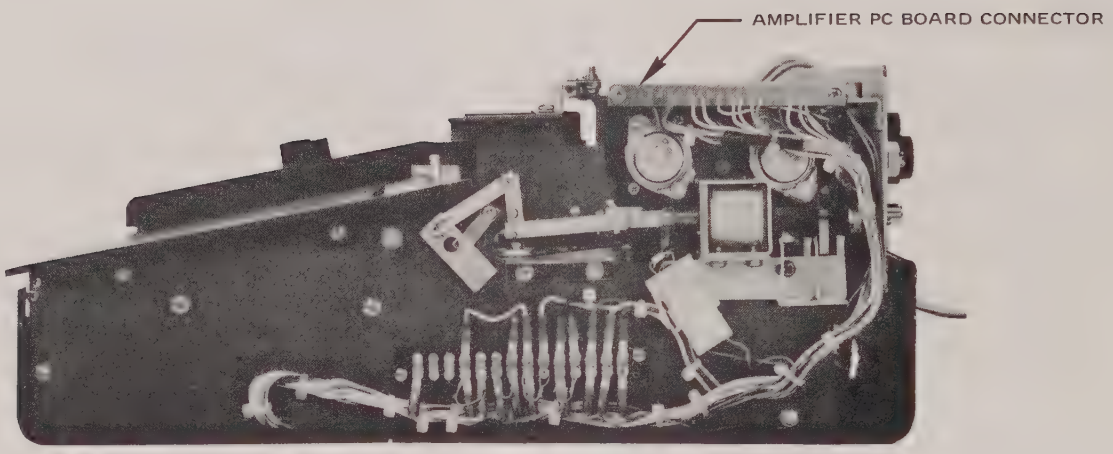


FIGURE 4-2. LOCATION OF AMPLIFIER PC BOARD CONNECTOR

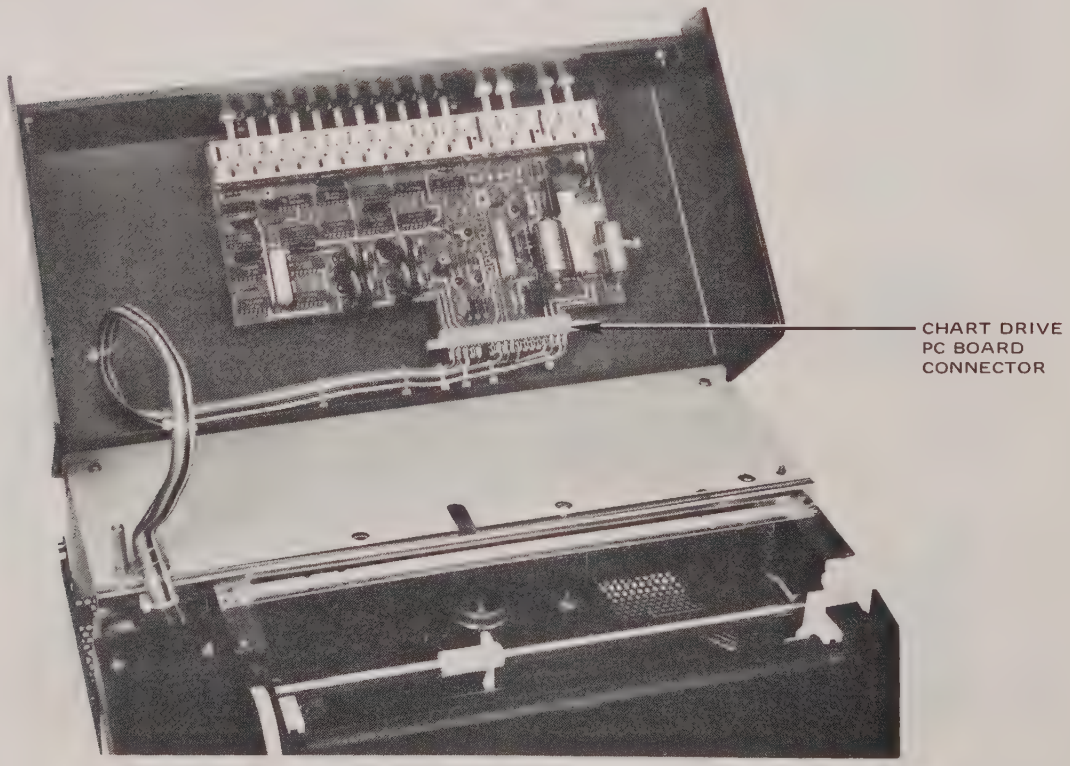


FIGURE 4-3. LOCATION OF CHART DRIVE PC BOARD CONNECTOR

screws in the motor shield. Stringing is now accessible.

9) To reassemble the recorder, reverse the above procedure.

• Complete Disassembly

To disassemble the recorder for installation of accessories, amplifier servicing, restringing pen drive cable, potentiometer replacement, chart drive motor replacement or power supply servicing, proceed as follows. Be sure the power cord and signal leads are disconnected.

1) Follow steps 1), 2), and 6), of preceding paragraph on partial disassembly.

2) Turn the recorder upside down while holding the platen down.

3) Refer to Figures 4-2 and 4-4; remove the 8 screws indicated by numbers 1 through 8. Remove the bottom screen. (It is not necessary to remove the screws in the recorder feet). Stepper motor, gear box, and drive mechanisms are now accessible.

4) Refer to Figure 4-4; remove the 10 screws indicated by numbers (9) through (18) in the power supply assembly. The paper tear bar is removed and both side panels fall free.

5) Unplug the power supply connector(s) from the power supply printed circuit board(s). See Figure 4-5. The power supply assembly is now available for servicing.

WARNING

Use extreme caution while performing maintenance on a disassembled recorder since primary power terminals are exposed.

6) Turn the recorder over and face the rear of the instrument. With a Phillips screwdriver, loosen (do not remove) the three screws along the bottom of the input panel.

7) Follow steps (4) through (7) of preceding

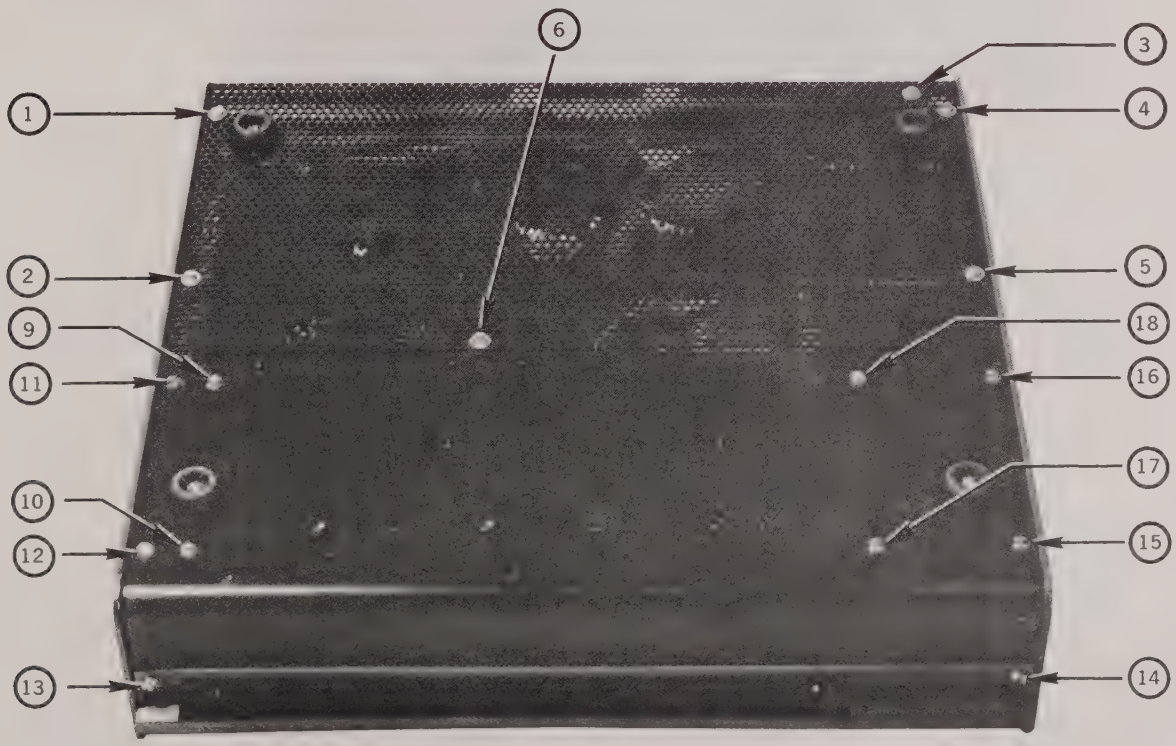


FIGURE 4-4. LOCATION OF CABINET BOTTOM MOUNTING SCREWS

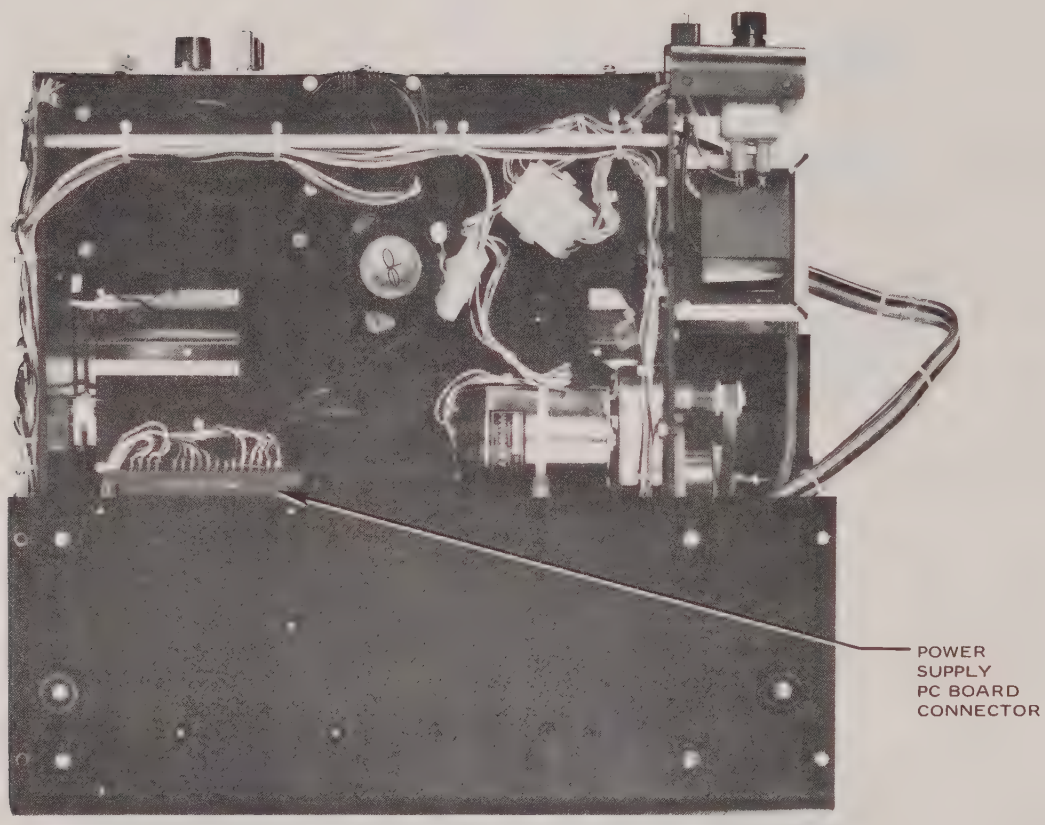


FIGURE 4-5. LOCATION OF POWER SUPPLY PC BOARD CONNECTOR

paragraph on partial disassembly. The amplifier is now available for servicing, stringing is accessible, and potentiometers may be replaced.

8) To reassemble the recorder, reverse the above procedure.

4.7 CALIBRATION

Series G-2500 recorders are completely calibrated before shipment. This procedure can be used to change the operating characteristics of the recorder or to restore the original characteristics after service.

1) Check that the recorder is supplied with chart paper, pen, and ink. If necessary, refer to Section 3 and replenish the paper and ink.

2) Connect the recorder to a proper source of power and turn the POWER switch to ON.

3) Press 1.0 IN/MIN CHART speed pushbutton switch. Chart paper should pass through recorder at the rate of 1 in/min.

4.7.1 Zero Adjustment

The CAL adjustment can be set as follows to provide full scale deflection of the pen assembly with a maximum input signal corresponding to the setting of the SPAN switch, or the voltage value of the plug-in span element.

1) Short the input terminals together and note that the pen is aligned with the zero position on the chart. Remove the short.

2) On multiple span recorders, set the SPAN switch at any desired position.

3) Connect a fixed dc voltage between the input terminals corresponding to the SPAN switch setting (or to the voltage value of the plug-in span element).

4) Rotate the CAL adjustment so that the pen is in exact alignment with the desired full scale position on the chart.

5) Disconnect the fixed dc voltage from the input terminals.

4.7.2 Calibrate Adjustment

The CAL adjustment can be set as follows to provide full scale deflection of the pen assembly with a maximum input signal corresponding to the setting of the SPAN switch, or the voltage value of the plug-in span element.

1) Short the input terminals together and note that the pen is aligned with the zero position on the chart. Remove the short.

NOTE

If necessary, perform the Zero Adjustment procedure given in paragraph 4.7.1.

2) On multiple span recorders, set the SPAN switch at any desired position.

3) Connect a fixed dc voltage between the input terminals corresponding to the SPAN switch setting (or to the voltage value of the plug-in span element).

4) Rotate the CAL adjustment so that the pen is in exact alignment with the desired full scale position on the chart.

5) Disconnect the fixed dc voltage from the input terminals.

4.7.3 Gain and Damping Adjustments

The GAIN and DAMP adjustments of the recorder can be set as follows:

1) Short the signal input terminals together. Set the ZERO control so that the pen comes to rest at the center of the chart paper.

2) Turn the DAMP adjustment fully CW (maximum damping).

3) Remove the short from the signal input terminals and connect a dc voltage of an amplitude that will drive the pen less than half scale.

4) Short the input terminals and allow the pen to make a short trace on the paper.

5) Reverse the polarity of the voltage applied in step (3); then momentarily remove the short connected in step (4), allowing the pen to make a second short trace.

6) Determine the horizontal distance between the traces made in steps (4) and (5). If it is greater than 20% of one small division of the chart paper (0.2% full scale), the GAIN adjustment should be turned slightly clockwise and steps (3) through (5) should be repeated.

7) Disconnect the short from the signal input terminals and observe the trace made by the pen. Note that the pen does not overshoot the point on the chart paper at which it finally comes to rest.

8) Turn the DAMP adjustment slightly CCW, reconnect the short across the input terminals, then remove it again.

9) Observe the trace made on the chart paper. Repeat step (8) until there is evidence of a small amount of overshoot; then, turn the DAMP adjustment slightly CW.

NOTE

The ideal trace (critical damping) forms a 90° angle where it changes from a horizontal to a vertical direction. Do not turn the DAMP adjustment so far as to round off this "corner".

10) Make the zero adjustment described in paragraph 4.7.1 and check the calibrate adjustment described in paragraph 4.7.2.

NOTE

If it is necessary to reset the CAL adjustment, repeat steps (1) through (10), paragraph 4.7.3.

4.7.4 Displaced Zero Operation
The ZERO adjustment is set according to the procedure given in paragraph 4.7.1. For displaced zero operation, the zero position on the chart is other than the left-hand or right-hand margin.

4.7.5 Suppressed Zero Operation
The following calibration procedure can be used when suppressed zero operation is desired:

1) Follow the procedures given in paragraph 4.7.1 through 4.7.3.

2) Select an appropriate position of the SPAN switch, or insert a plug-in span element of appropriate voltage rating.

3) Connect to the signal input terminals a fixed dc voltage of the value to be represented by the zero position on the chart paper.

NOTE

Observe polarity of input terminals. This voltage must not exceed the full scale value of the span selected.

4) Set the ZERO control so that the pen is in exact alignment with the desired zero position on the chart paper.

5) Disconnect the fixed dc voltage from the input terminals.

4.8 RESTRINGING PEN DRIVE CABLE

Partially disassemble the recorder following the procedure of paragraph 4.6. You will now be facing the *rear* of the recorder; left-hand and right-hand orientation during this procedure is from this perspective. Remove old cable, if necessary.

4.8.1 Single Channel Recorders
Refer to Figure 4-6 which shows cable correctly strung.

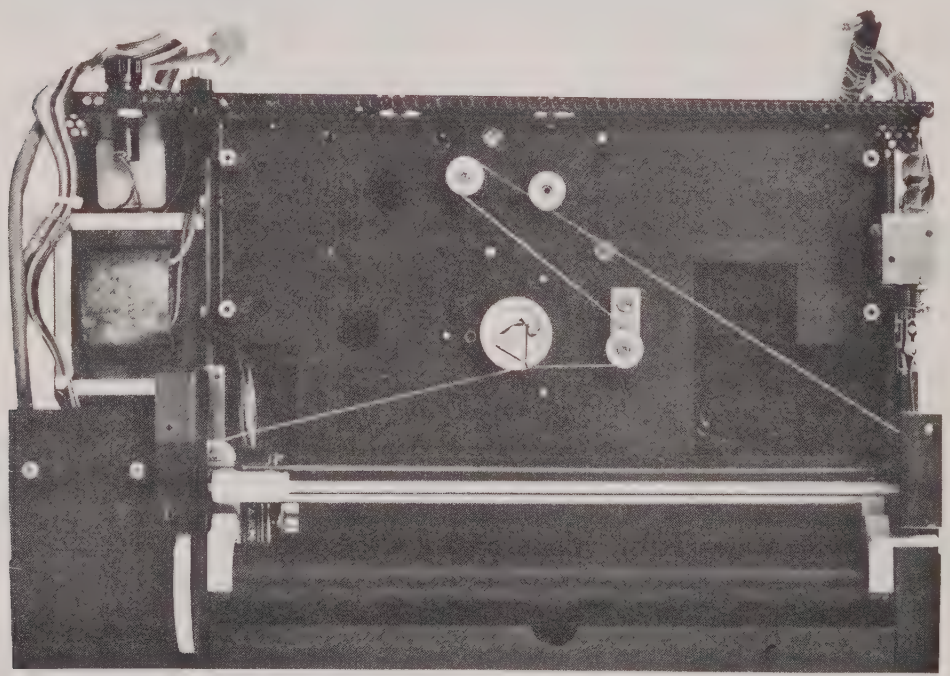


FIGURE 4-6. RESTRINGING SINGLE PEN DRIVE CABLE

1) Rotate the potentiometer sheave fully CCW. Be sure the hole in the sheave faces the front of the recorder (away from you). If it does not, loosen the set screw in the sheave, adjust the sheave position, and retighten the set screw.

2) Using a length of cable (60 inches), insert about 2 inches through the hole in the sheave. Wrap the cable 1 turn CW around the left-hand 4-40 screw inside the sheave and tighten the screw.

3) Wrap the cable ½ turn CCW around the spring-loaded idler pulley at the left of the potentiometer. Pull the cable taut enough so the pulley arm moves through a 120° arc.

4) Wrap ½ turn CW around the stationary idler pulley at the rear of the recorder.

5) Wrap 1 turn CW around the servo motor sheave.

6) Wrap ¼ turn CW around the pulley on the bracket at the left-hand side of the recorder.

7) Slide the pen bearing to its extreme right-hand limit of travel.

8) Insert the cable through the slot in the pen bearing.

9) Loop the cable under the corner of the pen bearing and back through the slot. Repeat the loop to obtain two loops.

10) Wrap the cable ½ turn CW around the pulley on the bracket at the right-hand side of the recorder.

11) Holding the cable taut, rotate the potentiometer CW, wrapping the cable from the spring-loaded idler pulley around the sheave until the pen bearing reaches its full left-hand limit of travel. The cable must be aligned progressively UP the sheave.

12) Place the free end of the cable on the potentiometer sheave beneath the cable from the spring-loaded idler pulley and wrap the cable CCW around the potentiometer sheave to the hole. Insert the cable end through the hole. Wrap the cable 1 turn CW around the remaining 4-40 screw inside the sheave and tighten the screw.

13) Move the pen bearing back and forth to assure that the stringing system is operating smoothly. When the pen bearing moves from right to left, the cable from the spring-loaded idler pulley should wrap progressively *UP* the potentiometer sheave. When the pen bearing moves from left to right, the cable leaving the right-hand pulley should wrap progressively *DOWN* the potentiometer sheave.

14) Cut off excess cable, leaving approximately ½ inch inside the sheave.

15) Proceed to paragraph 4.9 for potentiometer phasing procedure.

4.8.2 Front Pen on Dual Channel Recorders

Refer to Figure 4-7 which shows cable correctly strung. On recorders having a side-by-side pen system, remove the stop temporarily from the front pen rod.

1) Rotate the potentiometer sheave fully CCW. Be sure the hole in the sheave faces the front of the recorder (away from the technician). If it does not, loosen the set screw in the sheave, adjust the sheave position, and retighten the set screw.

2) Using a length of cable (60 inches), insert about 2 inches through the hole in the sheave. Wrap the cable 1 turn CW around the left-hand 4-40 screw inside the sheave and tighten the screw.

3) Wrap the cable ½ turn CCW around the spring-loaded idler pulley at the left of the potentiometer. Pull the cable taut enough so the pulley arm moves through a 120° arc.

4) Wrap ½ turn CW around the stationary idler pulley at the center rear of the recorder.

5) Wrap 1 turn CW around the left-hand servo motor sheave.

6) Wrap ¼ turn CW around the lower rear pulley on the bracket at the left-hand side of the recorder.

7) Wrap ¼ turn CW around the front pulley on

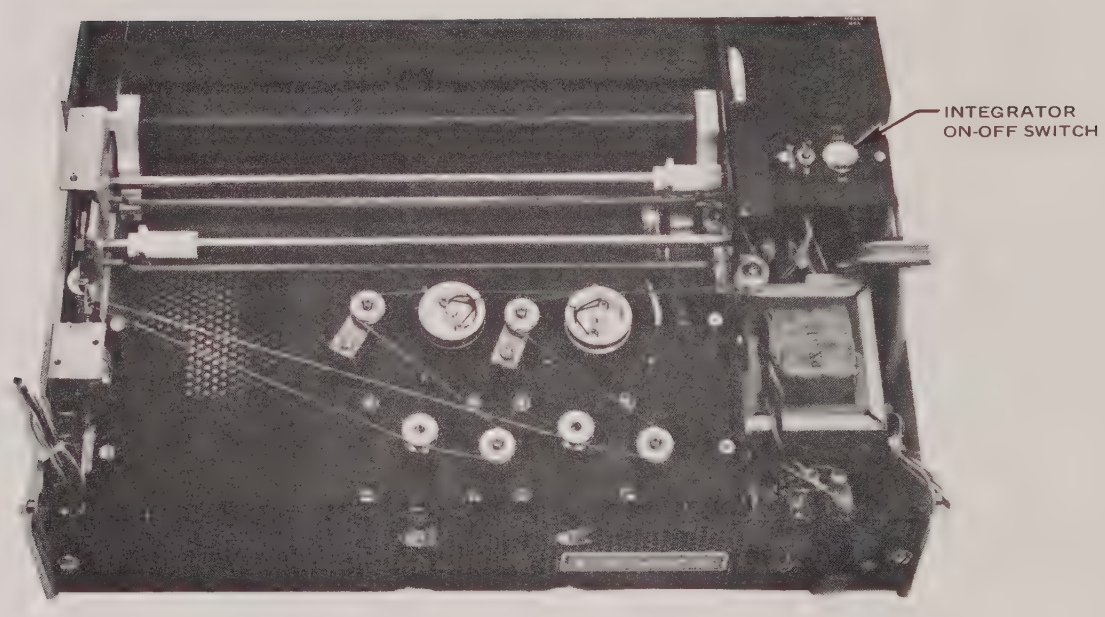


FIGURE 4-7. RESTRINGING DUAL PEN DRIVE CABLES

the bracket at the left-hand side of the recorder.

8) Slide the pen bearing to its extreme right-hand limit of travel.

9) Insert the cable through the slot in the pen bearing.

10) Loop the cable under the corner of the pen bearing and back through the slot. Repeat the loop to obtain two loops.

11) Wrap the cable ¼ turn CW around the front pulley on the bracket at the right-hand side of the recorder.

12) Wrap ¼ turn CW around the lower rear pulley on the bracket at the right-hand side of the recorder.

13) Holding the cable taut, rotate the potentiometer CW, wrapping the cable from the spring-loaded idler pulley around the sheave until the pen bearing reaches its full left-hand limit of travel. The cable must be aligned progressively *UP* the sheave.

14) Place the free end of the cable on the potentiometer sheave beneath the cable from the spring-loaded idler pulley and wrap the cable CCW around the potentiometer sheave to the hole. Insert the cable end through the hole. Wrap the cable 1 turn CW around the remaining 4-40 screw inside the sheave and tighten the screw.

15) Move the bearing back and forth to assure that the stringing system is operating smoothly. When the pen bearing moves from right to left, the cable from the spring-loaded idler pulley should wrap progressively *UP* the potentiometer sheave. When the pen bearing moves from left to right, the cable leaving the right-hand pulley should wrap progressively *DOWN* the potentiometer sheave. Make sure string does not overlap on pulley.

16) Cut off excess cable, leaving approximately ½ inch inside the sheave.

17) Proceed to paragraph 4.9 for potentiometer phasing procedure.

4.8.3 Rear Pen on Dual Channel Recorders

Refer to Figure 4-6 which shows cable correctly strung. On recorders having a side-by-side pen system, remove the stop temporarily from the rear pen rod.

1) Rotate the potentiometer sheave fully CCW. Be sure the hole in the sheave faces the front of the recorder (away from the technician). If it does not, loosen the set screw in the sheave, adjust the sheave position, and retighten the set screw.

2) Using a length of cable (60 inches), insert about 2 inches through the hole in the sheave. Wrap the cable 1 turn CW around the left-hand 4-40 screw inside the sheave and tighten the screw.

3) Wrap the cable ½ turn CCW around the spring-loaded idler pulley at the left of the potentiometer. Pull the cable taut enough so the pulley arm moves through a 120° arc.

4) Wrap ½ turn CW around the right-hand stationary idler pulley at the rear of the recorder.

5) Wrap 1 turn CW around the right-hand servo motor sheave.

6) Wrap ½ turn CW around the upper rear pulley on the bracket at the left-hand side of the recorder.

7) Slide the pen bearing to its extreme right-hand limit of travel.

8) Insert the cable through the slot in the pen bearing.

9) Loop the cable under the corner of the pen bearing and back through the slot. Repeat the loop to obtain two loops.

10) Wrap the cable ½ turn CW around the upper rear pulley on the bracket at the right-hand side of the recorder.

11) Holding the cable taut, rotate the potentiometer CW, wrapping the cable from the spring-loaded idler pulley around the sheave until the pen bearing reaches its full left-hand limit of travel. The cable must be aligned progressively *UP* the sheave.

12) Place the free end of the cable on the potentiometer sheave beneath the cable from the spring-loaded idler pulley and wrap the cable CCW around the potentiometer sheave to the hole. Insert the cable end through the hole. Wrap the cable 1 turn CW around the remaining 4-40 screw inside the sheave and tighten the screw.

13) Move the pen bearing back and forth to assure that the stringing system is operating smoothly. When the pen bearing moves from right to left, the cable from the spring-loaded idler pulley should wrap progressively *UP* the potentiometer sheave. When the pen bearing moves from left to right, the cable leaving the right-hand pulley should wrap progressively *DOWN* the potentiometer sheave.

14) Cut off excess cable, leaving approximately ½ inch inside the sheave.

15) Proceed to paragraph 4.9 for potentiometer phasing procedure.

4.9 POTENTIOMETER PHASING

Referring to Figure 4-8 for location of potentiometer, phase potentiometer as follows:

1) Move the pen bearing to its extreme right-hand limit of travel, i.e., right-hand meaning the rear of the recorder toward the operator, and the recorder upright.

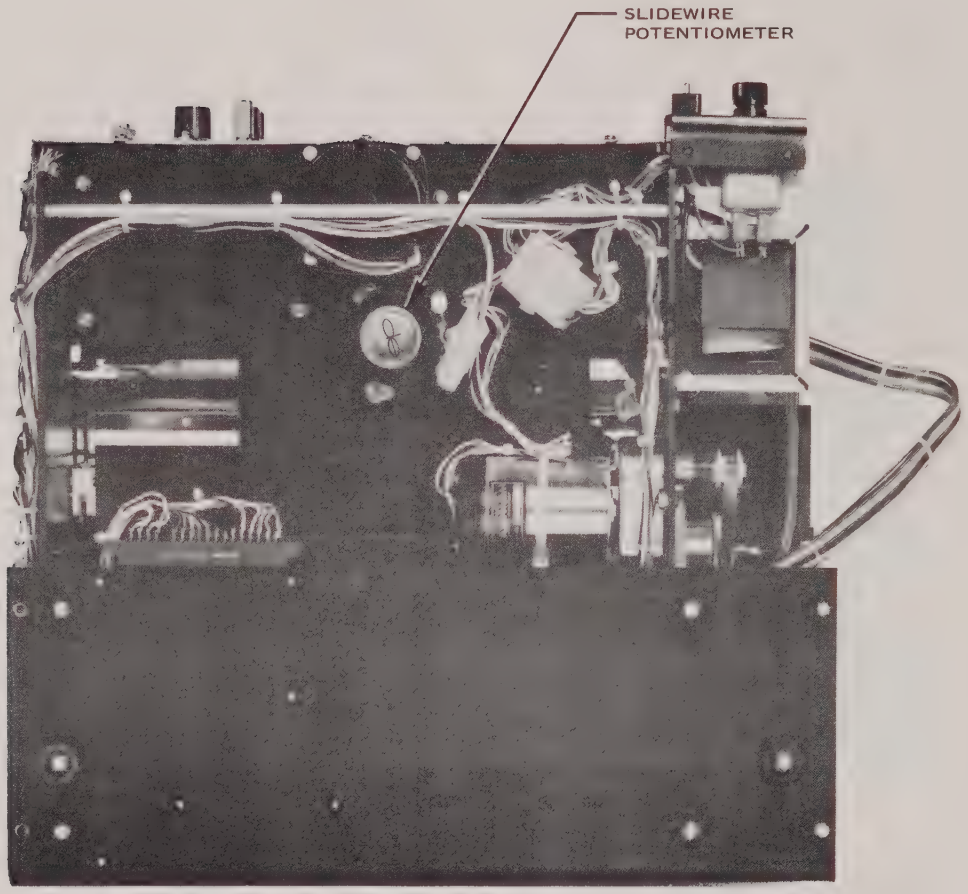


FIGURE 4-8. LOCATION OF SLIDEWIRE POTENTIOMETER

2) Connect the leads of an ohmmeter (reading on lowest resistance scale) between the CCW and S terminals of the potentiometer. If the ohmmeter reading is 125 ± 10 ohms, the potentiometer is properly phased. If not, proceed to step (3).

3) Loosen the set screw in the potentiometer sheave using a 6-32 Allen wrench.

4) Holding the pen bearing in position (extreme right-hand limit), rotate the potentiometer shaft until the ohmmeter reads 125 ± 10 ohms.

5) Tighten the set screw in the potentiometer sheave.

6) On recorders having a side-by-side pen system, replace the pen stop(s) on the pen rod(s).

7) If, after the recorder has been placed in operation, the ZERO control does not permit full scale zero adjustment, the potentiometer must be rephased as described above. If less than full scale zero adjustment is obtained, the potentiometer resistance should be set greater than 125 ohms.

4.10 POTENTIOMETER REPLACEMENT

Disassemble the recorder following steps (1) through (8) of paragraph 4.6. You will now be facing the rear of the recorder. On recorders having

side-by-side pen system, remove the stop temporarily from the appropriate pen rod.

1) Move the pen bearing to its extreme right-hand, (i.e., right-hand meaning the rear of the recorder toward the operator and the recorder upright) limit of travel.

2) Loosen the set screw in the potentiometer sheave using a 6-32 Allen wrench.

3) Push the sheave down onto the servo mounting plate and tape the sheave in place with masking tape. The stringing should not be disturbed.

4) Turn the recorder upside down. See Figure 4-4.

5) Unsolder the leads and capacitor from the potentiometer, noting the relative locations of the leads on the potentiometer terminals.

6) Remove the three 4-40 screws and potentiometer clamps and remove the potentiometer.

7) Rotate the shaft of the new potentiometer fully CCW.

8) Position the potentiometer so the terminals face the front of the recorder and insert the potentiometer shaft into the sheave. Replace the three 4-40 screws and potentiometer clamps.

9) Solder the leads and capacitor to the potentiometer terminals.

10) Turn the recorder over.

11) Remove the masking tape from the potentiometer sheave. Raise the sheave until the cable from the sheave to the right-hand pulley is horizontal. Retighten the set screw in the potentiometer sheave.

12) Phase the potentiometer, following the instructions given in paragraph 4.9.

4.11 CONVERSION BETWEEN SIDE-BY-SIDE (5-INCH SPAN) AND CROSS-OVER (10-INCH SPAN) PEN SYSTEMS

The pen travel stops, with side-by-side pen operation, are located on the pen rods. To convert to cross-over (10-inch span) pen systems, perform the following steps:

1) Remove the pen stops from the pen rods.

2) Change the scale to indicate a 10-inch span.

3) Change to an appropriate chart paper.

4) On single-span recorders, change the span element - see Table 1-2.

5) Reset the CAL adjustment following the procedure given in paragraph 4.7.2.

6) Reverse the polarity of the input signal to the front pen.

To convert from cross-over (10-inch span) to a side-by-side pen system, the pen stops are positioned to permit 5-inch pen travel and the scale is changed accordingly. Follow steps (3), (4), (5), and (6) above. In addition, for multiple-span recorders the SPAN switch must be set at twice the desired span. For example, if 10 mV full scale was being monitored over the 10-inch span, and it is desired to monitor this over the 5-inch span the SPAN switch must be set at 20 mV.

This section comprises the following illustrated parts lists:

Digital Chart Drive Assembly Parts List 5-2

Basic Recorder Electrical Parts Lists 5-5

Basic Recorder Mechanical Parts List 5-12

Electrical Parts Lists - Accessories and Options 5-17

Replacement Parts and Kits 5-18

DIGITAL CHART DRIVE ASSEMBLY PARTS LIST

Refer to Figure 5-1 for location of parts listed below.

C1	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
C2	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
C3	Capacitor, 1.0 mfd, 250V, 20%	05-000275-00
C4	Capacitor, Elect., 1000 mfd, 25V	05-000492-00
C5	Capacitor, 1500 mfd, 15V	
C6	Capacitor, Elect., 200 mfd, 12V	41-506225-00
C7	Capacitor, Mylar, .1 mfd, 50V	05-000236-00
C8	Capacitor, Elect., 10 mfd, 6V	41-506213-00
C9	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
C10	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
C11	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
C12	Capacitor, Ceramic, .01 mfd, 100V	05-000029-00
CR1	Diode	14-000018-00
CR2	Diode, Bridge	00-908047-01
CR3	Diode	14-000018-00
CR4	Diode	14-000004-00
CR5	Diode	14-000018-00
CR6	Diode	14-000018-00
CR7	Diode	14-000018-00
F1	Fuse, ½ amp	19-000037-00
IC1	IC, Flip Flop	14-000534-00
IC2	IC, Amplifier	14-000569-00
IC3	IC, Flip Flop	14-000534-00
IC4	IC, Flip Flop	14-000534-00
IC5	IC, Flip Flop	14-000534-00
IC6	IC, Triple 3 Input Gate	14-000536-00
IC7	IC, Flip Flop	14-000550-00
IC8	IC, Flip Flop	14-000550-00
IC9	IC, Flip Flop	14-000550-00
IC10	IC, Amplifier	14-000569-00
IC11	IC, Quad 2 Input Gate	14-000535-00
IC12	IC, Dual 4 Input Gate	14-000557-00
IC13	IC, Flip Flop	14-000534-00
IC14	IC, Flip Flop	14-000534-00
IC15	IC, Quad 2 Input Gate	14-000535-00
Q1	Transistor, 2N3391A	62-003391-00
Q2	Transistor, 2N3391A	62-003391-00
Q3	Transistor, 2N3391A	62-003391-00
Q4	Transistor, 2N3391A	62-003391-00
Q5	Transistor, 2N3643	14-000508-00
Q6	Transistor, 2N5296	14-000582-00
Q7	Transistor, 2N3643	14-000508-00
Q8	Transistor, 2N3643	14-000508-00
Q9	Transistor, 2N3643	14-000508-00
Qp1	Pad, Transistor	62-899951-00
Qp2	Pad, Transistor	62-899951-00
Qp3	Pad, Transistor	62-899951-00
Qp4	Pad, Transistor	62-899951-00
Qp5	Pad, Transistor	62-899953-00
Qp7	Pad, Transistor	62-899953-00

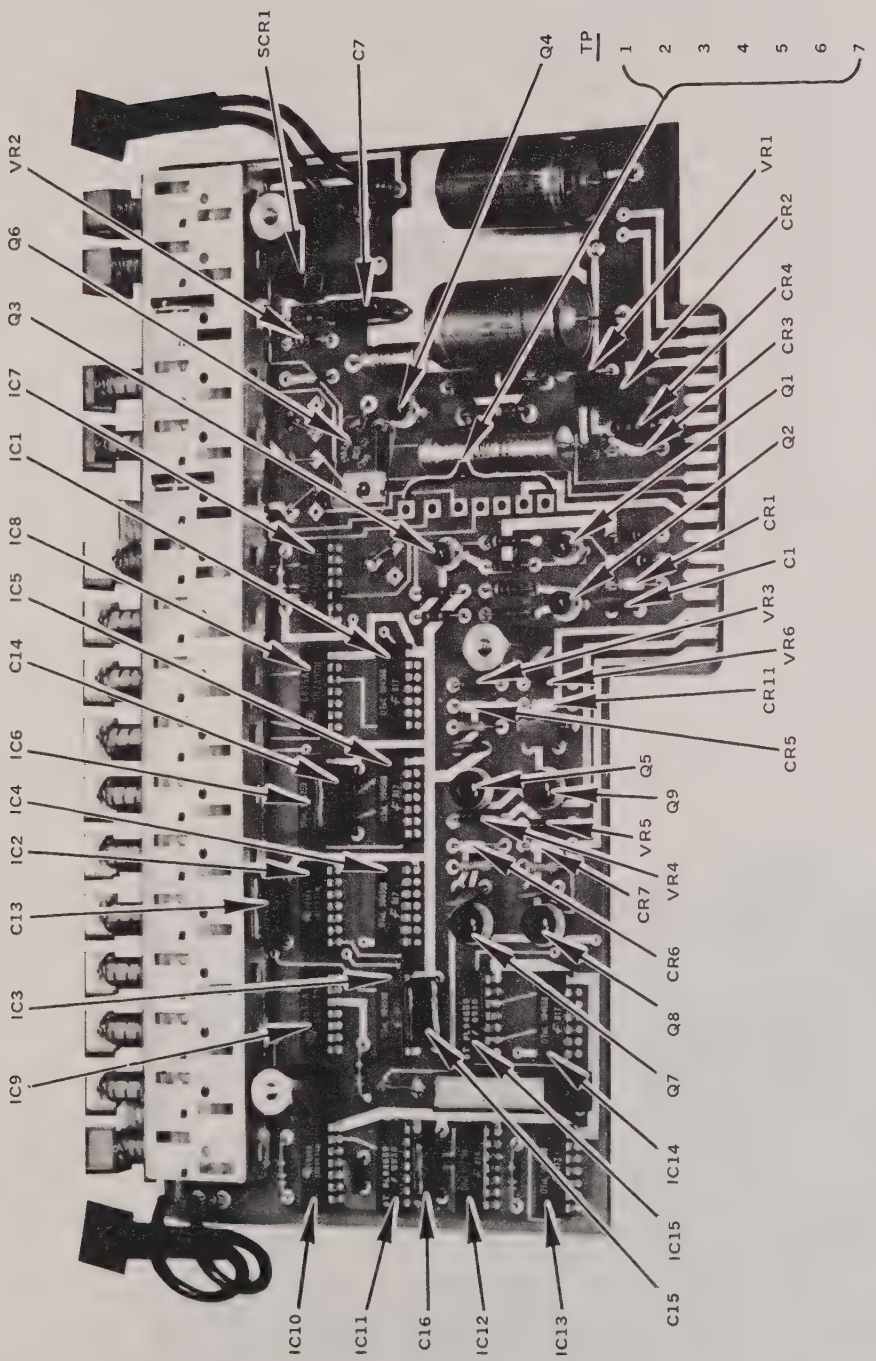

SCR1
C7
Q4
TP
1
2
3
4
5
6
7
VR2
Q6
Q3
IC7
IC1
IC8
IC5
C14
IC6
IC4
IC2
C13
IC3
IC9
VR1
CR2
CR4
CR3
Q1
Q2
CR1
C1
VR3
VR6
CR11
CR5
Q5
Q9
VR5
VR4
CR7
CR6
Q8
Q7
IC14
IC15
C15
IC10
IC11
C16
IC12
IC13

FIGURE 5-1

Qp8	Pad, Transistor	62-899953-00
Qp9	Pad, Transistor	62-899953-00
R1	Resistor, Comp., 10K ohm, ¼w, 5%	39-000369-00
R2	Resistor, Comp. 100K ohm, ¼w, 5%	32-301610-00
R3	Resistor, Comp., 4.7K ohm, ¼w, 5%	32-301447-00
R4	Resistor, Comp., 270 ohm, ¼w, 5%	32-301327-00
R5	Resistor, Comp., 1K ohm, ¼w, 5%	32-301410-00
R6	Resistor, Comp., 8.2K ohm, ¼w, 5%	39-000379-00
R7	Resistor, Comp., 2.2K ohm, ¼w, 5%	32-301422-00
R8	Resistor, Comp., 5.6K ohm, ¼w, 5%	32-301456-00
R9	Resistor, Comp., 3.3K ohm, ¼w, 5%	32-301433-00
R10	Resistor, Comp., 3.3K ohm, ¼w, 5%	32-301433-00
R11	Resistor, Comp., 3.3K ohm, ¼w, 5%	32-301433-00
R13	Resistor, Comp., 100 ohm, 1w, 5%	33-301310-00
R14	Resistor, Comp., 2.2K ohm, ½w, 5%	39-000354-00
R15	Resistor, Comp., 510 ohm, ¼w, 5%	32-301351-00
R16	Resistor, Metal Film, 604 ohm, 1/8w, 1%	39-000907-00
R17	Resistor, Metal Film, 604 ohm, 1/8w, 1%	39-000907-00
R18	Resistor, Metal Film, 604 ohm, 1/8w, 1%	39-000907-00
R19	Resistor, Metal Film, 604 ohm, 1/8w, 1%	39-000907-00
R20	Resistor, Comp., 3.3K ohm, ¼w, 5%	32-301433-00
SCR1	Pad, Transistor	62-899953-00

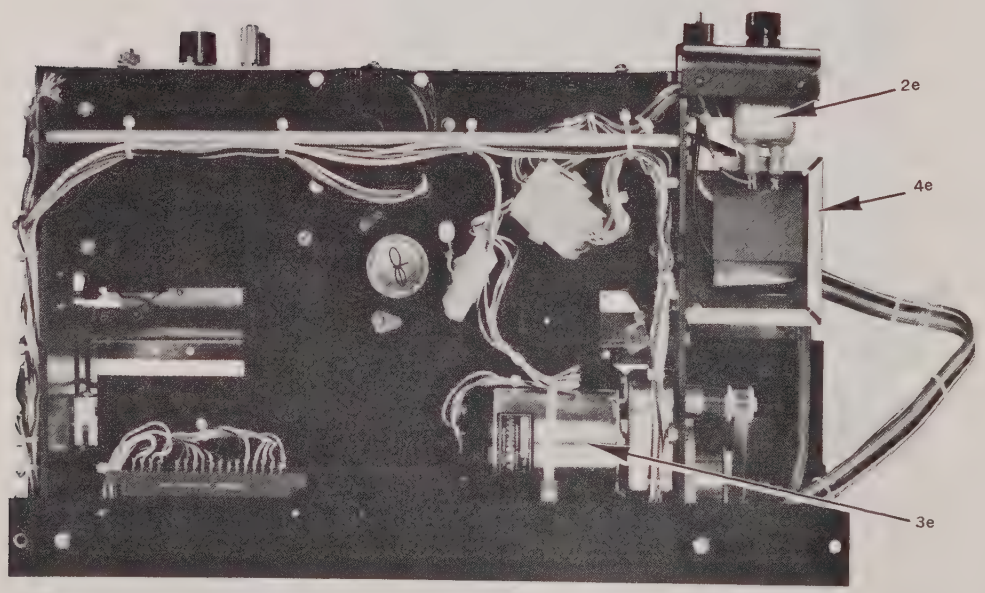


FIGURE 5-2

BASIC RECORDER ELECTRICAL PARTS LISTS

Refer to Figures 5-2 through 5-6 for location of parts listed below.

Power Supply

BR201	Diode, Bridge BR84C	00-908047-01
BR202	Diode, Bridge BR84C	00-908047-01
BR203	Diode, Bridge BR84C	00-908047-01
C201	Capacitor, 2μfd, 200V ±5%	41-729580-00
C202	Capacitor, 100μfd, 50V	41-506229-00
C203	Capacitor, 500μfd, 50V	05-000417-00
C204	Capacitor, 100μfd, 50V	41-506229-00
C205	Capacitor, 100μfd, 50V	41-506299-00
C206	Capacitor, 200μfd,10V	41-506225-00
C207	Capacitor, 50μfd, 25V	
C208	Capacitor, 50μfd, 25V	
C209 (60 Hz)	Capacitor, .5μf, 200V, ±5%	00-907527-01
C209 (50 Hz)	Capacitor, 1μfd, 200V, ±5%	41-729513-00
CR201	Diode, LMZX22	66-393402-00
CR202	Diode, Zener, IN936	66-300936-00
CR203	Diode, LMZX22	66-393402-00
CR204	Diode, LMZX22	66-393402-00
Q201	Transistor, 40319	62-989600-00
Q202	Transistor, 2N3391A	62-003391-00
Q203	Transistor, 2N3638	62-903638-00
Q204	Transistor, 2N3053	62-003053-00
R201	Resistor, 1.5K, 1w, ±5%	33-301415-00
R202	Resistor, 560 ohms, ¼w, ±5%	32-301356-00
R203	Resistor, 820 ohms, 1w, ±5%	33-301382-00
R204	Resistor, 1.5K, ¼w, ±5%	32-301415-00
R205	Resistor, 1.8K, ¼w, ±5%	32-301418-00
R206	Resistor, 1.8K, ¼w, ±5%	32-301418-00
R207	Resistor, 150 ohms, ¼w, ±5%	32-301315-00
R208	Resistor, 1.2K, ¼w, ±5%	32-301412-00
R209	Resistor, 2.2K, ¼w, ±5%	32-301422-00
R210	Resistor, 2.2K, ¼w, ±5%	32-301422-00
R211	Resistor, 1.2K, ¼w, ±5%	32-301412-00
R212	Resistor, 150 ohm, ¼w, ±5%	32-301315-00

Parallel T Filter Assembly - Part No. C972-541

C701	Capacitor, 0.25 mfd, 200V	907-527-02
C702	Capacitor, 0.25 mfd, 200V	907-527-02
C703	Capacitor, 0.5 mfd, 200V	907-527-01
R701	Resistor, 11.3K, 1% (60 Hz only)	31-605-113
R701	Resistor, 13.7K, 1% (50 Hz only)	31-605-137
R702	Resistor, 11.3K, 1% (60 Hz only)	31-605-113
R702	Resistor, 13.7K, 1% (50 Hz only)	31-605-137
R703	Resistor, 5.62K, 1% (60 Hz only)	31-604-562
R703	Resistor, 6.81K, 1% (50 Hz only)	31-604-681

Servo Mounting Plate Assembly - Part No. D972-340

B304	Motor, servo	943-364
B305	Motor, servo	943-364
C304	Capacitor, 0.5 mfd, 200V	907-529-05
C305	Capacitor, 0.5 mfd, 200V	907-529-05
R301	Potentiometer, feedback	906-549
R302	Potentiometer, feedback	906-549

Power Supply Assembly - Part No. D972-088

L201	Choke, Tranex No. 1-0227 (230V Dual Channel only)	972-092
R213	Resistor, 350 ohms, 5w, 5% (230V Dual Channel only)	35-289-335
T201	Transformer, power	972-077

Miscellaneous Electrical Parts

1e	Pen Lift Solenoid (Figure 5-7)	48-000258-00
2e	R.F. Line Filter (Figure 5-2)	53-000450-00
3e	Motor, Logic Stepper (Chart Drive) (Figure 5-2)	30-000082-00
4e	T-301 Transformer (Figure 5-2)	53-000076-00
5e	Diode, Rect. (Pen Lift Solenoid) (Figure 5-7)	66-396832-00

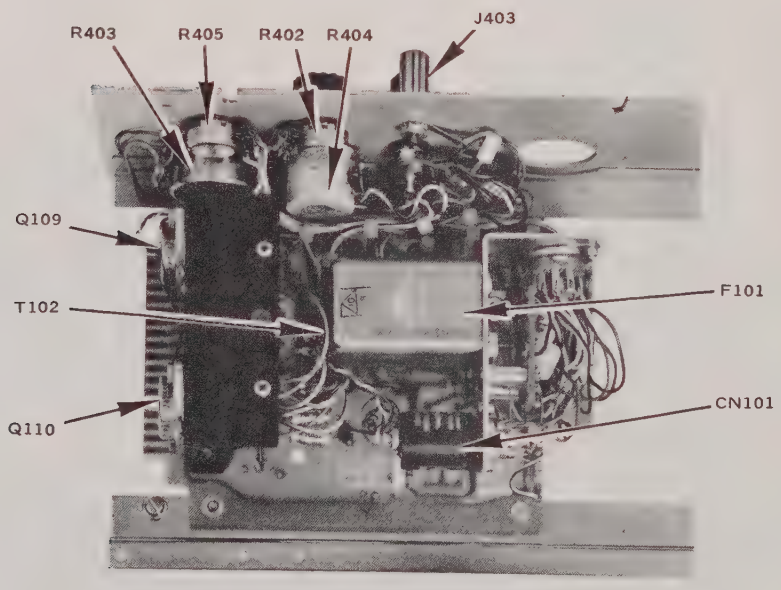


FIGURE 5-3

Amplifier Subassembly, Right Hand - Part No. D972-365
Amplifier Subassembly, Left Hand - Part No. D972-553

C401	Capacitor, 0.022 mfd, 200V	41-724-955-00
CH101	Contact Modulator	00-905-523-00
J401	Input Terminal, red	51-799-942-00
J402	Input Terminal, black	51-799-941-00
J403	Input Terminal, silver (uninsulated)	51-799-984-00
R401	Resistor, 15K, ¼w, 5%	32-301-515-00
R402	Potentiometer, 25K, Gain	00-972-523-02
R403	Potentiometer, 1.5K, Cal	37-586-415-00
R404	Potentiometer, 5K, Zero	00-971-570-00
R405	Potentiometer, 100K, Damp	00-972-523-03

Input Assembly - Part No. D972-478

T101	Transformer, input	00-907-753-00

Output Assembly - Part No. D972-477

C118	Capacitor, 0.5 mfd, 200V	00-907-529-05
C119	Capacitor, 0.5 mfd, 200V	00-907-529-05
Q109	Transistor, DTG-110	62-989-750-00
Q110	Transistor, DTG-110	62-989-750-00
T102	Transformer, output	00-972-070-00

Amplifier P.C. Board Assembly, R.H. Channel - Part No. D972-096
Amplifier P.C. Board Assembly, L.H. Channel - Part No. D972-480

C104	Capacitor, 150 mfd, 3V	41-506-227-00
C105	Capacitor, 35 mfd, 25V	41-506-000-00
C106	Capacitor, 0.022 mfd, 200V	41-724-955-00
C107	Capacitor, 100 mfd, 12V	41-506-253-00
C108	Capacitor, 35 mfd, 25V	41-506-000-00
C109	Capacitor, 10 mfd, 15V	41-506-239-00
C110	Capacitor, 100 mfd, 3V	41-506-002-00
C111	Capacitor, 0.033 mfd, 200V	41-724-973-00
C112	Capacitor, 25 mfd, 12V	41-506-219-00
C113	Capacitor, 100 mfd, 12V	41-506-253-00
C114	Capacitor, 10 mfd, 25V	41-506-244-00
C115	Capacitor, 10 mfd, 25V	41-506-244-00
C116	Capacitor, 10 mfd, 25V	41-506-244-00
C117	Capacitor, 0.056 mfd, 200V (-30 version only)	00-907-527-08
C117	Capacitor, 0.047 mfd, 200V (-01, -02, and -04 versions)	41-724-962-00
C120	Capacitor, 5 mfd, 12V	41-506-236-00
C121	Capacitor, 5 mfd, 12V	41-506-236-00
CR101	Diode, 1N475A	66-300-457-00
CR102	Diode, 1N457A	66-300-457-00
CR103	Diode, 1N457A	66-300-457-00
CR104	Diode, 1N457A	66-300-457-00
Q101	Transistor, 2N4250	62-904-250-00

Q102	Transistor, 2N3391A	62-003-391-00
Q103	Transistor, 2N3391A	62-003-391-00
Q104	Transistor, 2N3906	62-903-906-00
Q105	Transistor, 2N3391A	62-003-391-00
Q106	Transistor, 2N3391A	62-003-391-00
Q107	Transistor, 2N3053	62-903-053-00
Q108	Transistor, 2N3053	62-903-053-00
R104	Resistor, 18K, ¼w, 5%	32-301-518-00
R105	Resistor, 180K, ¼w, 5%	32-301-618-00
R106	Resistor, 100 ohms, ¼w, 5%	32-301-310-00
R107	Resistor, 22K, ¼w, 5%	32-301-522-00
R108	Resistor, 10K, ¼w, 5%	32-301-510-00
R109	Resistor, 150 ohms, ¼w, 5%	32-301-315-00
R110	Resistor, 18K, ¼w, 5%	32-301-518-00
R111	Resistor, 2.2K, ¼w, 5%	32-301-422-00
R112	Resistor, 18K, ¼w, 5%	32-301-518-00
R113	Resistor, 270 ohms, ¼w, 5%	32-301-327-00
R114	Resistor, 27K, ¼w, 5%	32-301-527-00
R115	Resistor, 15K, ¼w, 5%	32-301-515-00
R116	Resistor, 270 ohms, ¼w, 5%	32-301-327-00
R117	Resistor, 22K, ¼w, 5%	32-301-522-00
R118	Resistor, 10K, ¼w, 5%	32-301-510-00
R119	Resistor, 10K, ¼w, 5%	32-301-510-00
R120	Resistor, 2.7K, ¼w, 5%	32-301-427-00
R121	Resistor, 120 ohms, ¼w, 5%	32-301-312-00
R122	Resistor, 1.8K, ¼w, 5%	32-301-427-00
R123	Resistor, 120 ohms, ¼w, 5%	32-301-312-00
R124	Resistor, 2.7K, ¼w, 5%	32-301-427-00
R125	Resistor, 4.7K, ¼w, 5%	32-301-447-00
R126	Resistor, 1.5K, ½w, 5%	32-201-415-00
R127	Resistor, 4.7K, ¼w, 5%	32-301-447-00
R130	Resistor, 120 ohms, ¼w, 5%	32-301-312-00
R131	Resistor, 120 ohms, ¼w, 5%	32-301-312-00
R132	Resistor, 8.2K, ¼w, 5%	32-301-482-00
R133	Resistor, 220 ohms, ¼w, 5%	32-301-322-00
R134	Resistor, 220 ohms, ¼w, 5%	32-301-322-00
R135	Resistor, 8.2K, ¼w, 5%	32-301-482-00
R136	Resistor, 680 ohms, 1w, 5%	32-301-368-00
R137	Resistor, 2 ohms, ½w, 5%	32-201-120-00
R138	Resistor, 9.09K, M.F., 1% (-01 and -04 versions)	31-604-909-00
R139	Resistor, 972K, M.F., 1% (-01, -02, and -04 versions)	31-606-972-00
R139	Resistor, 715K, 1% (-03 version only)	31-606-715-00
R140	Resistor, 2 ohms, ½w, 5%	32-201-120-00
R141	Resistor, 2 ohms, ½w, 5%	32-201-120-00
R142	Resistor, 3.9K, ¼w, 5%	32-301-439-00
R143	Resistor, 33K, ¼w, 5%	32-301-533-00
R144	Resistor, 100K, 1%	31-606-100-00
R145	Resistor, 3.01K, 1%	31-224-301-00

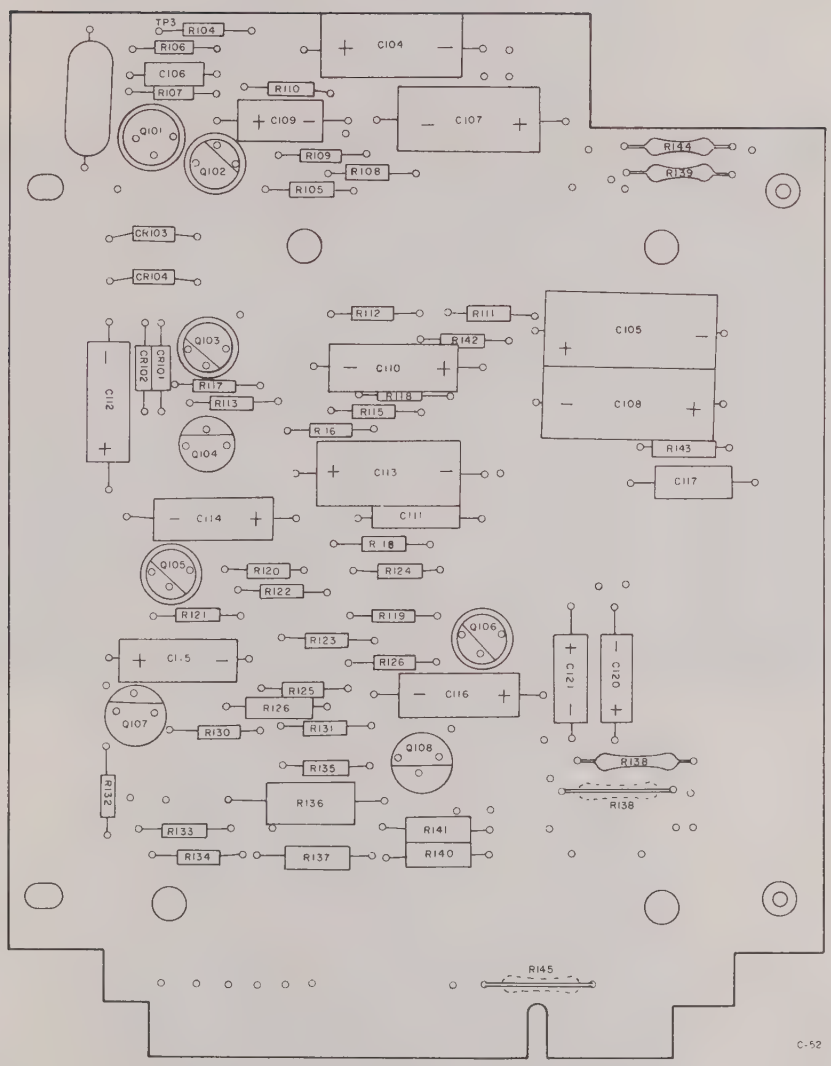

TP3
R104
R106
C106
R107
Q101
Q102
C104
R110
C109
C107
R109
R108
R105
R144
R139
CR103
CR104
Q103
CR102
CR101
C112
R117
R113
Q104
R112
R111
R142
C110
R118
R115
R 16
C105
C108
R143
C117
C113
C111
C114
R 18
Q105
R120
R124
R122
R121
R119
Q106
R123
R126
C115
C116
C121
C120
R125
R126
R131
R130
Q107
Q108
R135
R138
R138
R132
R136
R133
R134
R137
R141
R140
R145
C-52

FIGURE 5-4

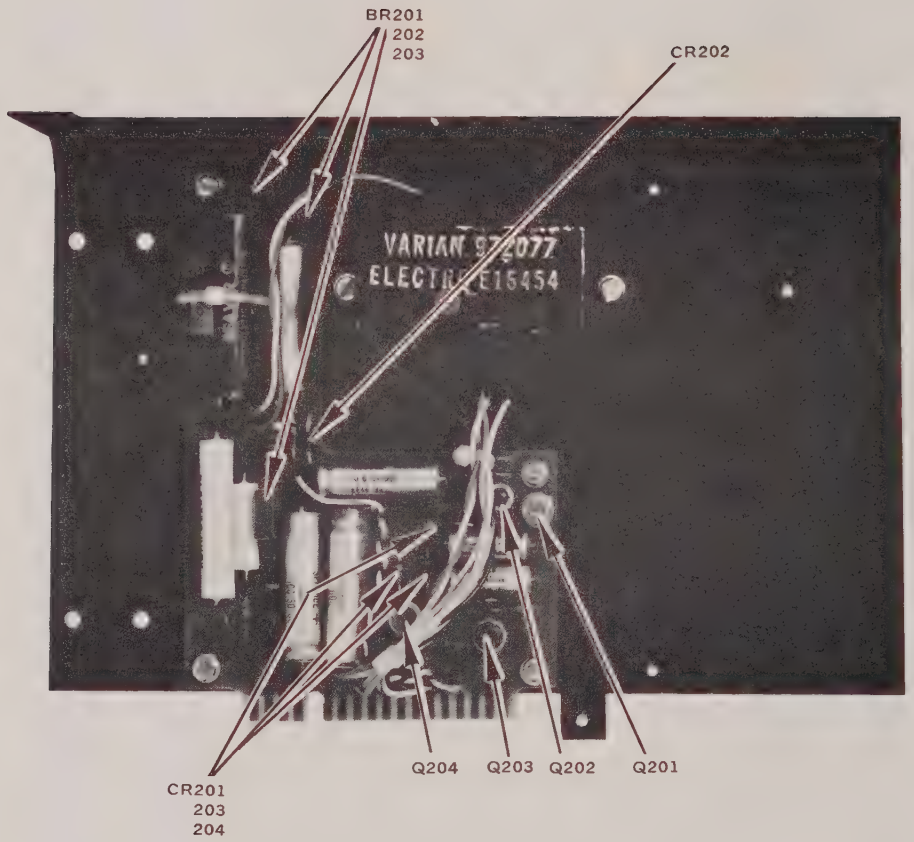

BR201
202
203
CR202
VARIAN 97-2077
ELECTRONICS E15454
CR201
203
204
Q204
Q203
Q202
Q201

FIGURE 5-5

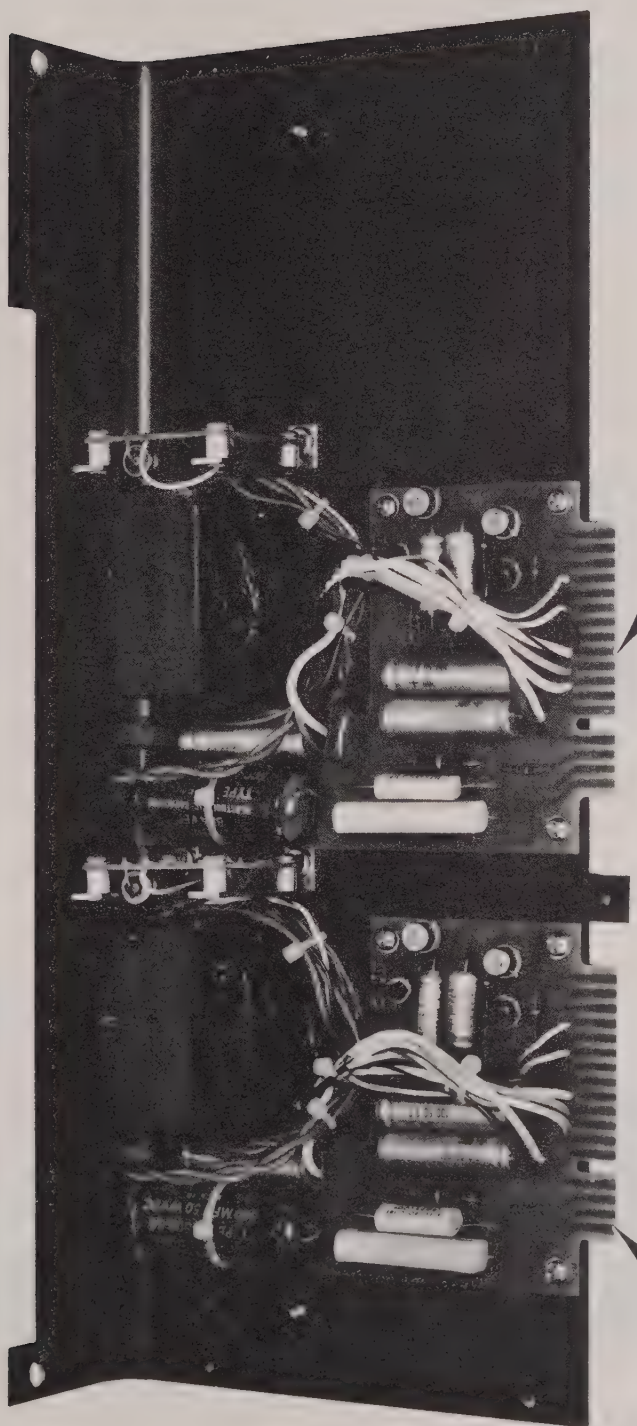

RIGHT HAND
POWER SUPPLY
PC BOARD
LEFT HAND
POWER SUPPLY
PC BOARD

FIGURE 5-6

BASIC RECORDER MECHANICAL PARTS LIST

Refer to Figures 5-7 through 5-11 for location of parts listed below.

1	Spring, Clutch	46-000051-00
2	Belt, Pulley ¼ wide	54-000033-00
3	Pulley, Gear Belt, DBL Flg.	54-000034-00
4	Pulley, Gear Belt, Single Flg.	54-000035-00
5	Assy, Gear Box, Modified	79-000111-00
6	Cord Dial (5 ft/channel)	88-589990-00
7	Sprocket, Chart	00-940362-00
8	Bar, Separotor	00-972343-00
9	Shaft, Pen	00-972344-00
10	BRKT, Pulley	00-972345-00
11	Platen	00-972346-00
12	Brg, Pen	00-972350-00
13	SPROCKET Drum	00-972353-00
14	Rod, Paper Guide	00-972362-02
15	Spring, Solenoid	00-972489-00
16	Hold Down, Paper, R.H.	00-972528-01
17	Hold Down, Paper, L.H.	00-972528-02
18	Assy, Cable Pulley	00-972669-00
19	Lift, Pen	00-972817-01
20	Link, Connecting	00-972818-00
21	Arm, Rear Pen	00-972820-00
22	Arm, Pen Lift	00-972821-00
23	Link, Solenoid	00-972823-00
24	Spring, Pen Lift	00-972824-00
25	Assy. Shaft Drum	02-001427-00

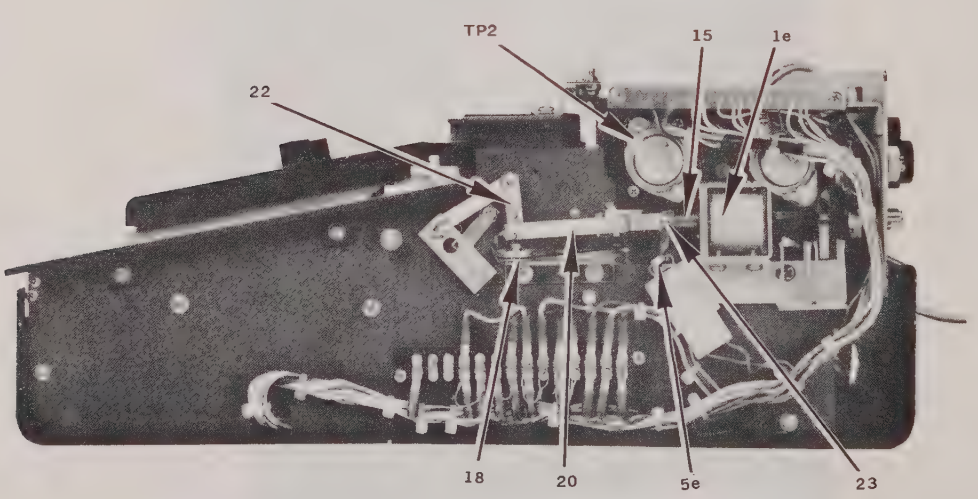


FIGURE 5-7

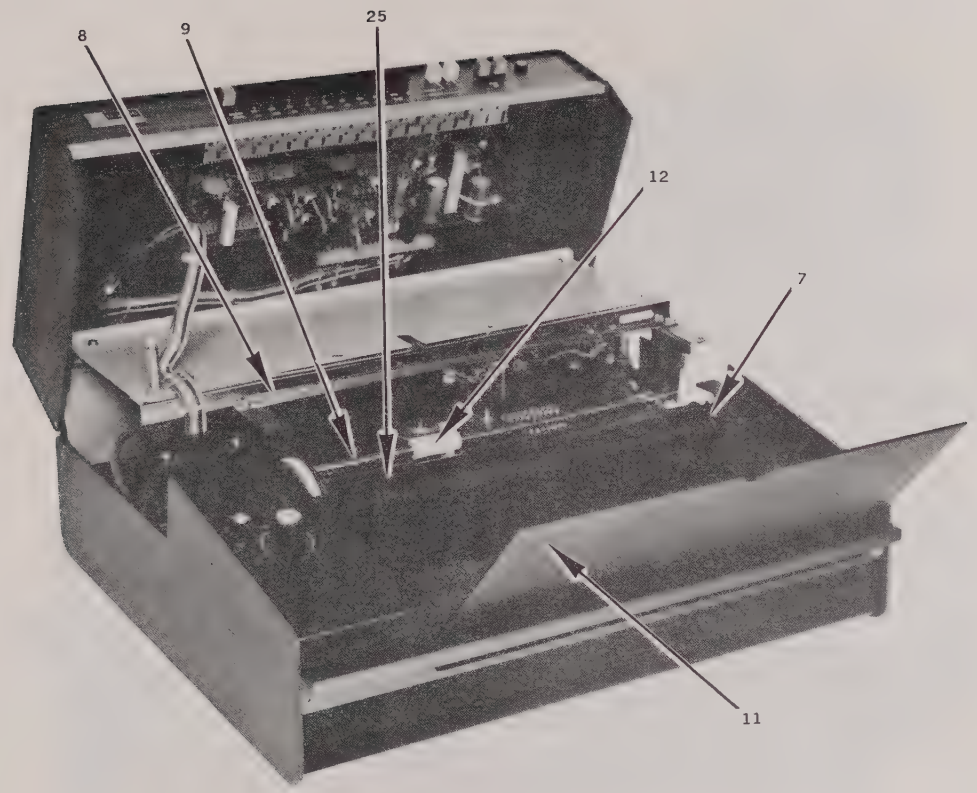


FIGURE 5-8

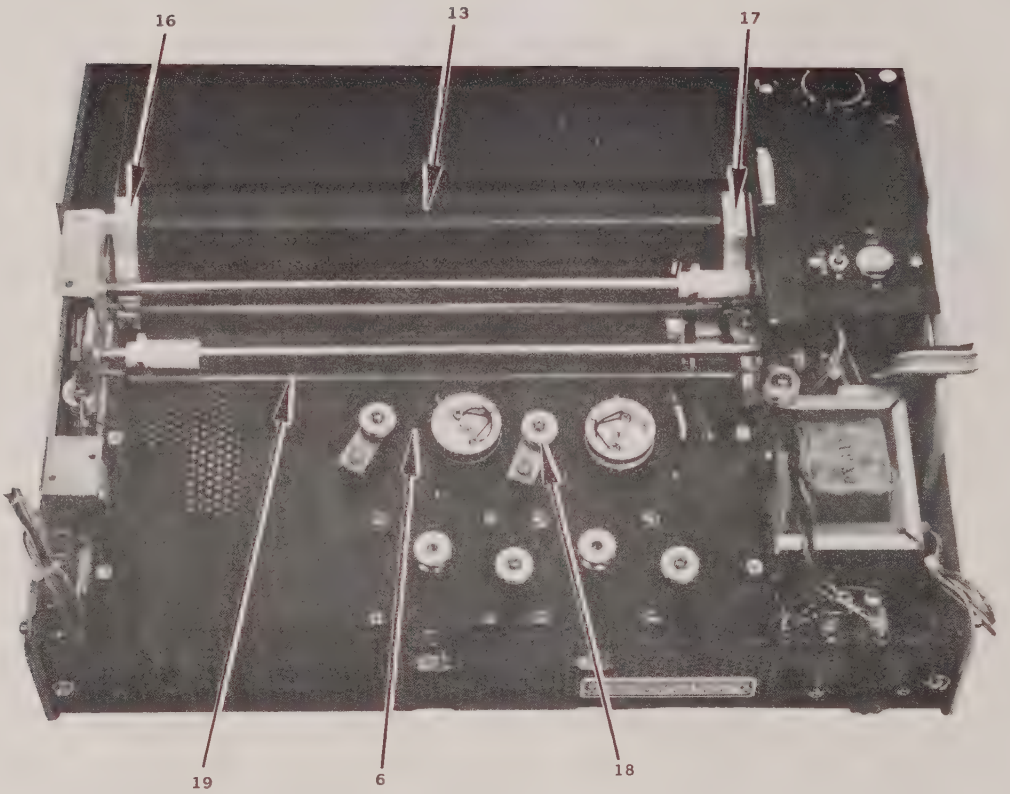


FIGURE 5-9

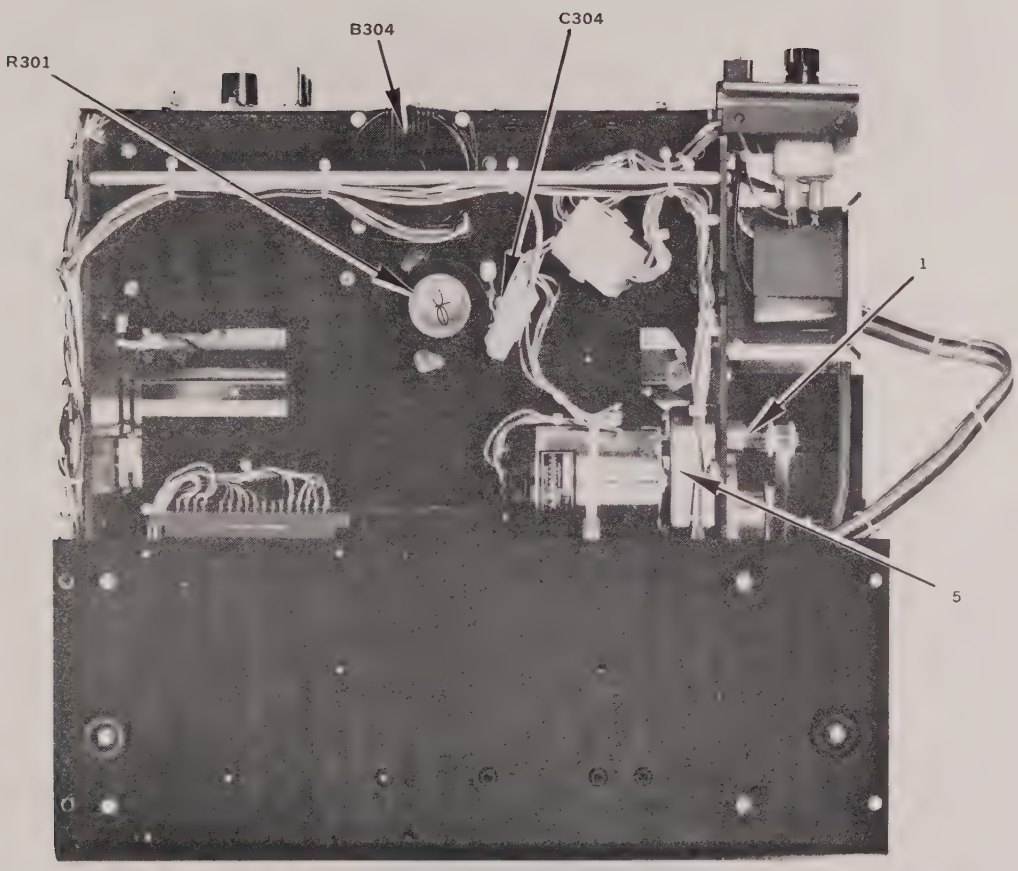


FIGURE 5-10

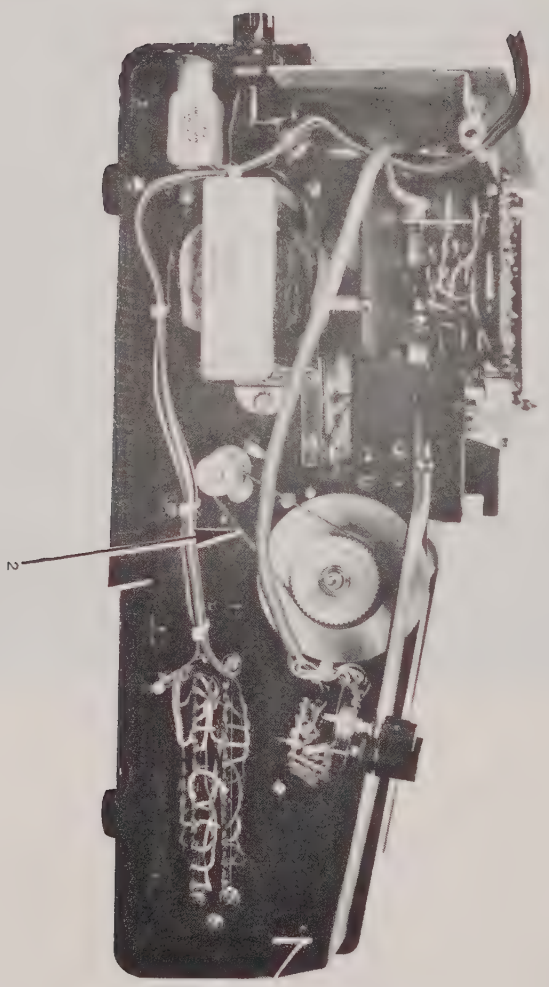


FIGURE 5-11

ELECTRICAL PARTS LISTS ACCESSORIES AND OPTIONS

Event Marker Kit - Part No. 972-640

C306	Capacitor, 0.022 mfd, 200V (left-hand)	41-724-955
C307	Capacitor, 0.022 mfd, 200V (left-hand)	41-724-955
C308	Capacitor, 0.022 mfd, 200V (right-hand)	41-724-955
C309	Capacitor, 0.022 mfd, 200V (right-hand)	41-724-955

Retransmitter Kit - Part No. 972-809

R304 and/or R305	Retransmitting potentiometer (specify resistance) (includes feedback potentiometer)	907-538-xx

REPLACEMENT PARTS AND KITS

Instruction manual	
Pen filler	907-674
Pen cleaning wire	972-499
Motor oil	88-299-450
Chart-weight clip	972-529
Fuse	See para. 2.2
Drive cable	88-589-990
Span element	See Table II
Potentiometer, feedback	906-549
Neon lamp	67-499-961
Alarm/Control switch kit (front)	972-466-01
Alarm/Control switch kit (rear)	972-466-02
Event Marker kit, right side	972-640-01
Event Marker kit, left side	972-640-02
Z-Fold Paper Tray	972-781-02
Retransmitter Kit (specify resistance)	972-809

WAVEFORMS (TYPICAL)

GENERAL CONDITIONS:

(1) TEKTRONIC Type 561B Scope; Type 3A9 vertical and 3B3 horizontal plug-ins.

(2) Scope Bandwidth: DC-1 MHz.

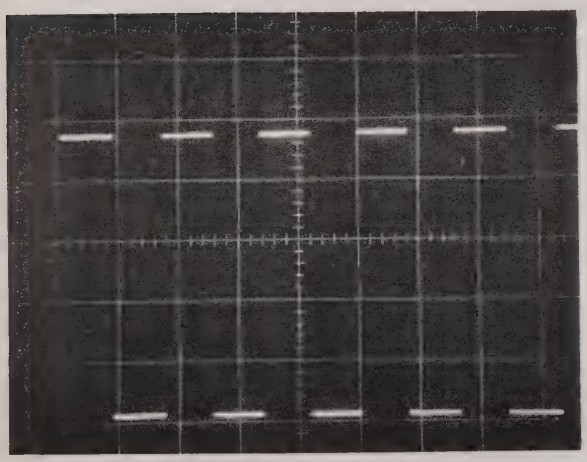
(3) Recorder Amplifier voltages measured at null. Inputs (+, -, ±) shorted together.

(4) Line Frequency/Voltage: 60Hz @ 117 Vac.

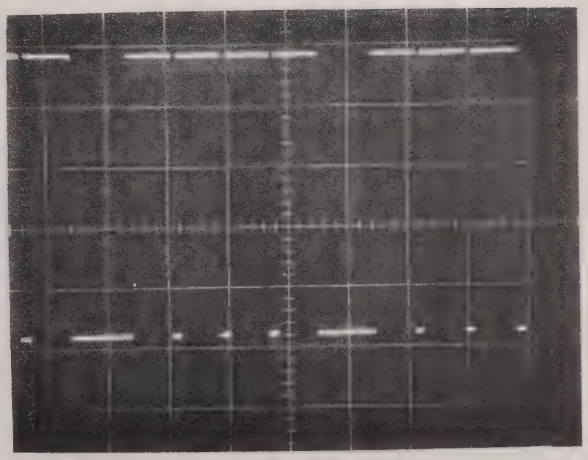
(5) Recorder pen(s) down.

(6) Chart running.

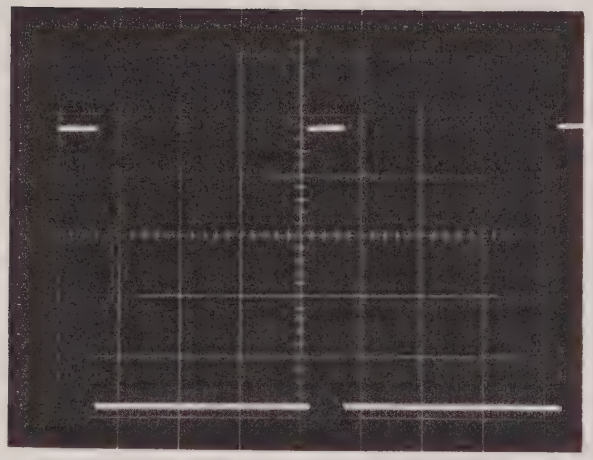
• **Digital Chart Drive PC Board**
Refer to Figure 5-1 for location of Test Points (TP) called out.



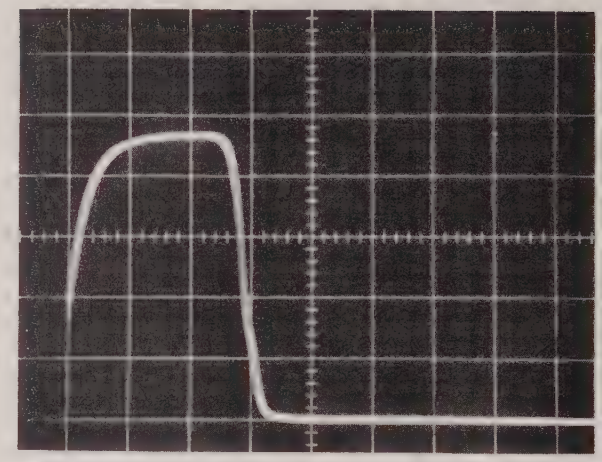
TP-1 (Divider Output)
1 V/cm Vert.
10 msec/cm Horz.
10 in/min chart speed



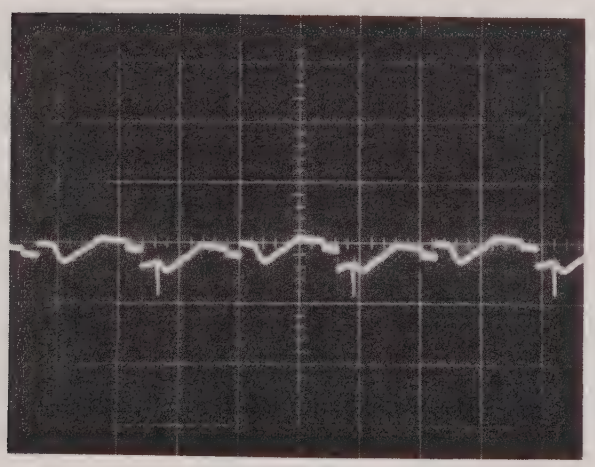
TP-1 (Divider Output)
1 V/cm Vert.
10 msec/cm Horz.
1000 in/hr chart speed



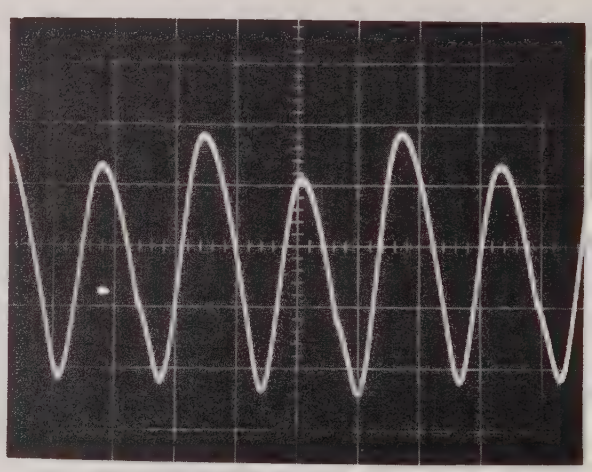
TP-3 (Schmidt Trigger Output
1 V/cm Vert.
1 msec/cm Horz.
Any chart speed



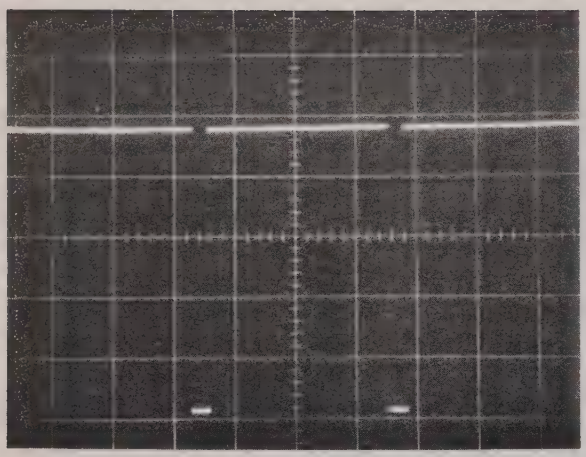
TP-4 (Divider Reset Line)
1 V/cm Vert.
2 μsec/cm Horz.
1000 in/hr chart speed



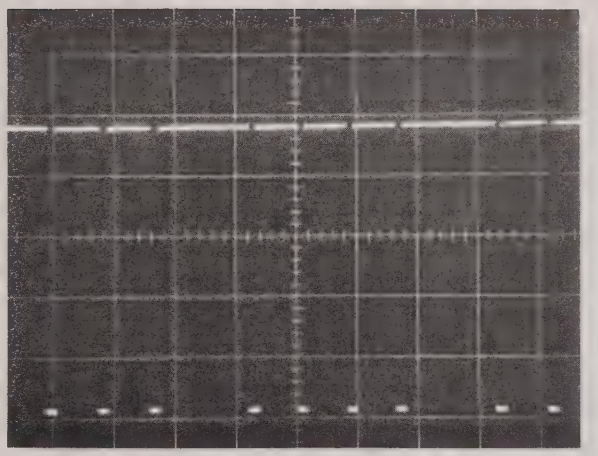
TP-5 (5 V Power Supply AC Component)
20 mV/cm Vert. (5 Vdc offset)
5 msec/cm Horz.



TP-6 (12 Vdc Power Supply AC Component)
0.2 V/cm Vert.
5 msec/cm Horz.

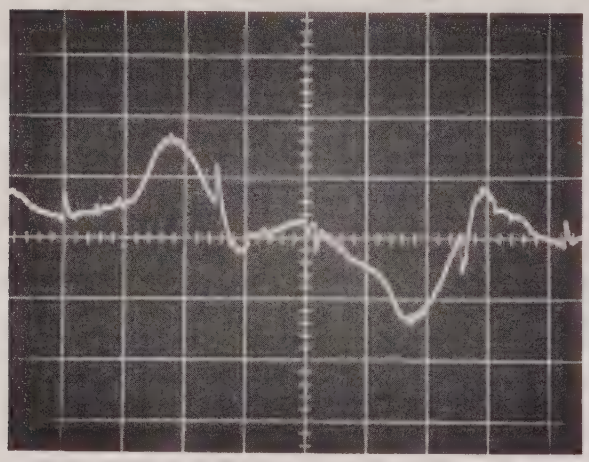


TP-7 (Pulse Stretcher Output)
1 V/cm Vert.
5 msec/cm Horz.
10 in/min chart speed

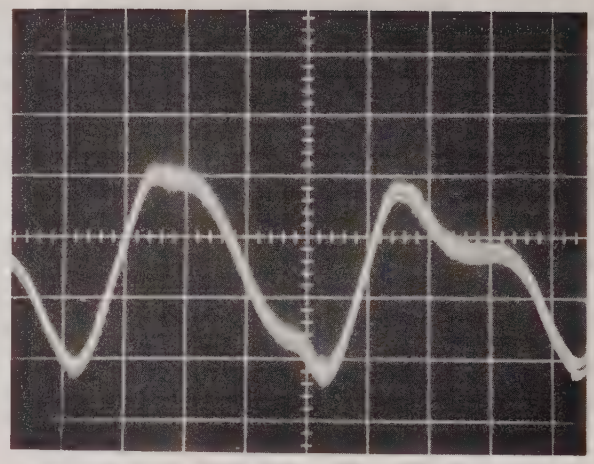


TP-7 (Pulse Stretcher Output)
1 V/cm Vert.
10 msec/cm Horz.
1000 in/hr chart speed.

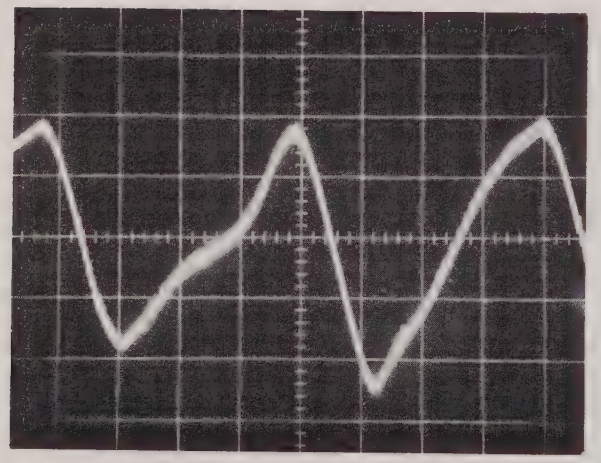
• **Amplifier Assembly**
Refer to Figures 5-4 and 5-7 for location of Test Points (TP) called out.



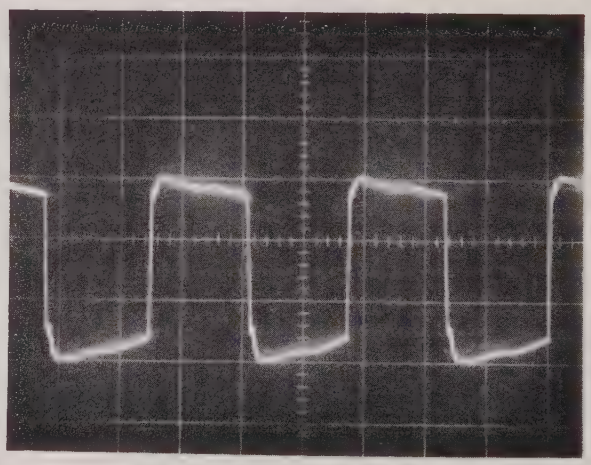
9 Vdc Reference
50 μV/cm Vert.
2 msec/cm Horz.



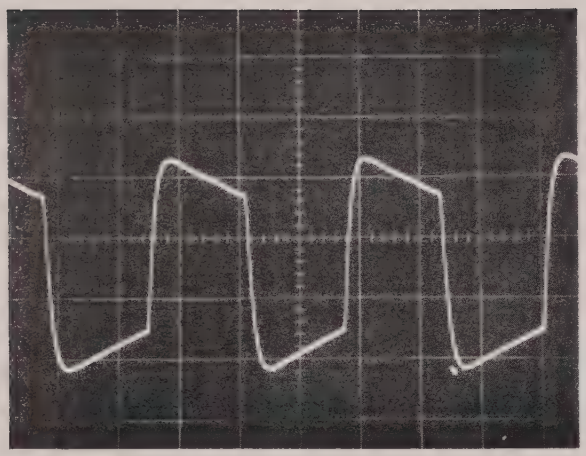
-21 Vdc Supply (AC Component)
0.5 V/cm Vert.
5 msec/cm Horz.
DC-1 KHz Bandwidth



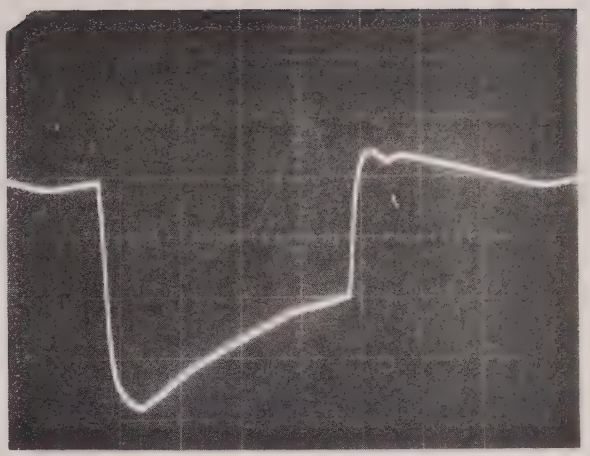
+21 Vdc Supply (AC Component)
0.5 V/cm Vert.
5 msec/cm Horz.
DC-1 KHz Bandwidth



TP-3 (1st Stage Base)
0.5 V/cm Vert.
5 msec/cm Horz.
DC-1 KHz
10 in Full Scale Offset
1 mV Range



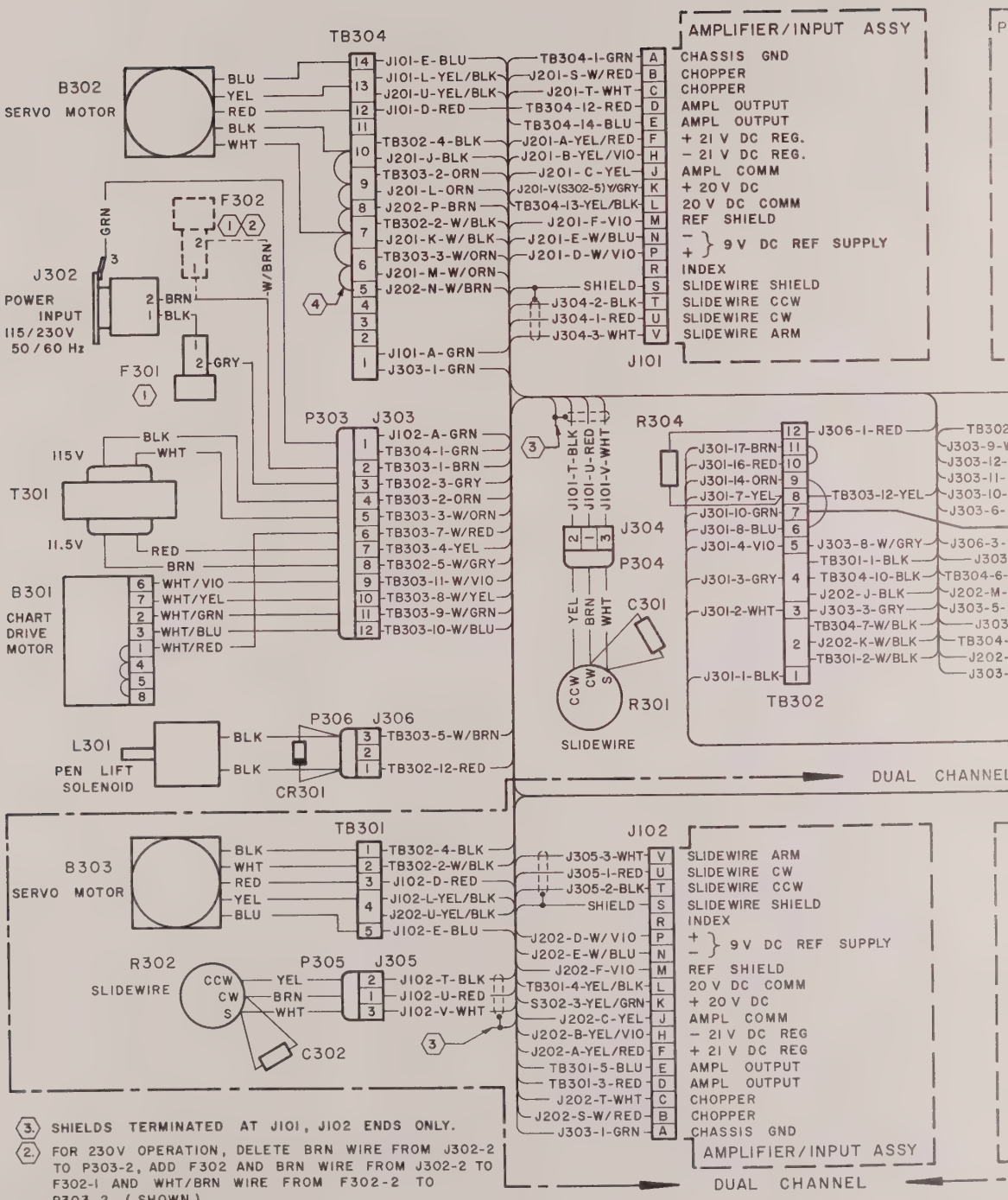
Gain Pot Wiper
¼ turn CCW from full CW position
20 mV/cm Vert.
5 msec/cm Horz.
10 inch Full Scale Offset
1 mV Range



TP-2 (Pwr Transistor Collector)
10 V/cm Vert.
2 msec/cm Horz.
DC-1 KHz Bandwidth

This section contains the following diagrams:

TITLE	DWG. NO.
G-2500 Wiring Diagram	75-000362-00
G-2500 Schematic Diagram	75-000363-00 (Sheets 1 & 2 of 2)
G-2500 Digital Chart Drive Schematic	75-000353-00



3. SHIELDS TERMINATED AT J101, J102 ENDS ONLY.

2. FOR 230V OPERATION, DELETE BRN WIRE FROM J302-2 TO P303-2, ADD F302 AND BRN WIRE FROM J302-2 TO F302-1 AND WHT/BRN WIRE FROM F302-2 TO P303-2 (SHOWN).

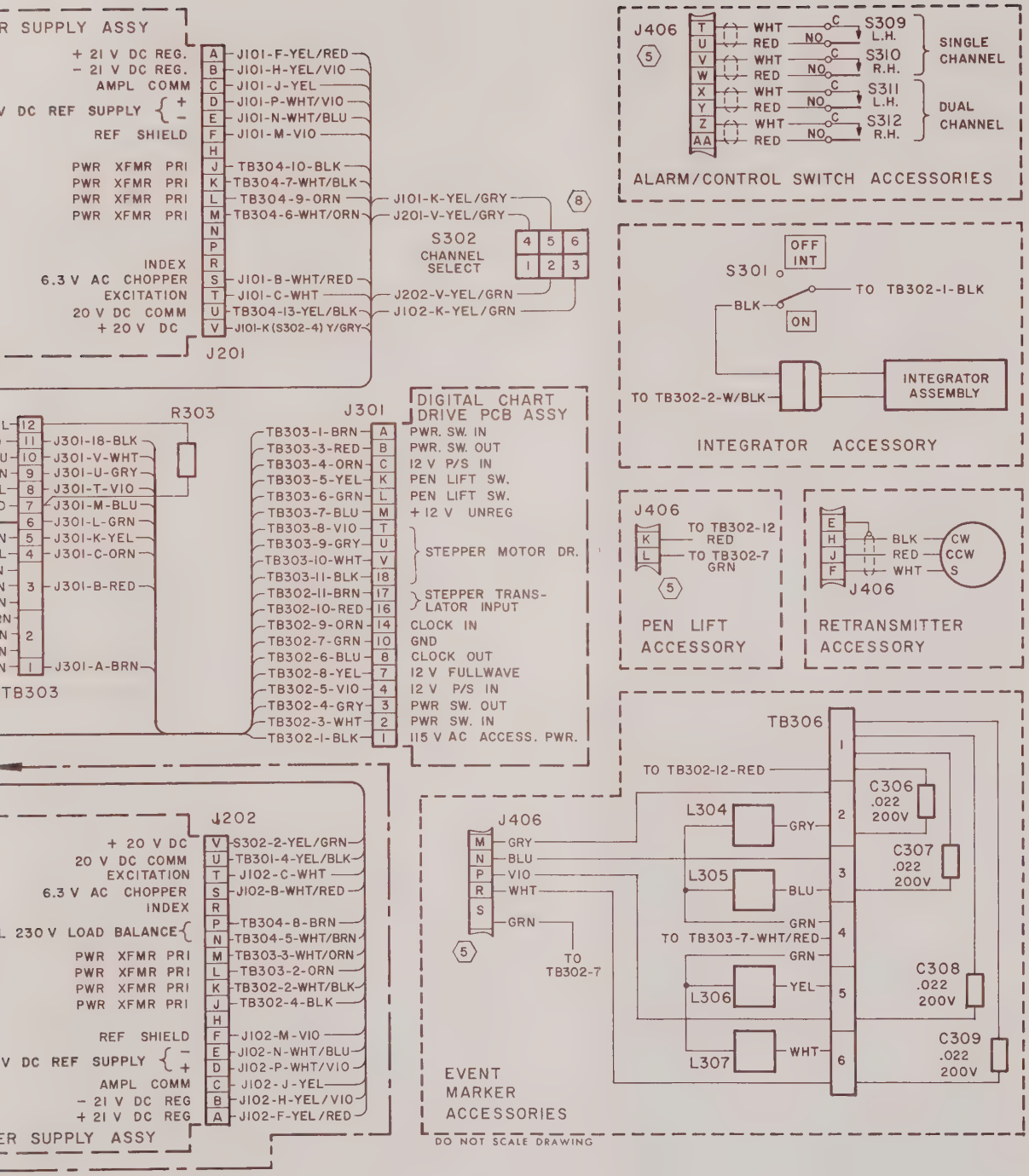
1. FUSES AS FOLLOWS:
   - 1.1 115 V 1 CHANNEL - F301 4/10 A SLO-BLO
   - 1.2 115 V 2 CHANNEL - F301 6/10 A SLO-BLO
   - 1.3 230V 1 CHANNEL - F301 2/10A, F302 2/10A
   - 1.4 230V 2 CHANNEL - F301 3/8 A, F302 3/8A

NOTES &

5. CLOSURE OF EXTERNAL CONTACTS ON J406 PINS ACTUATES FUNCTION.

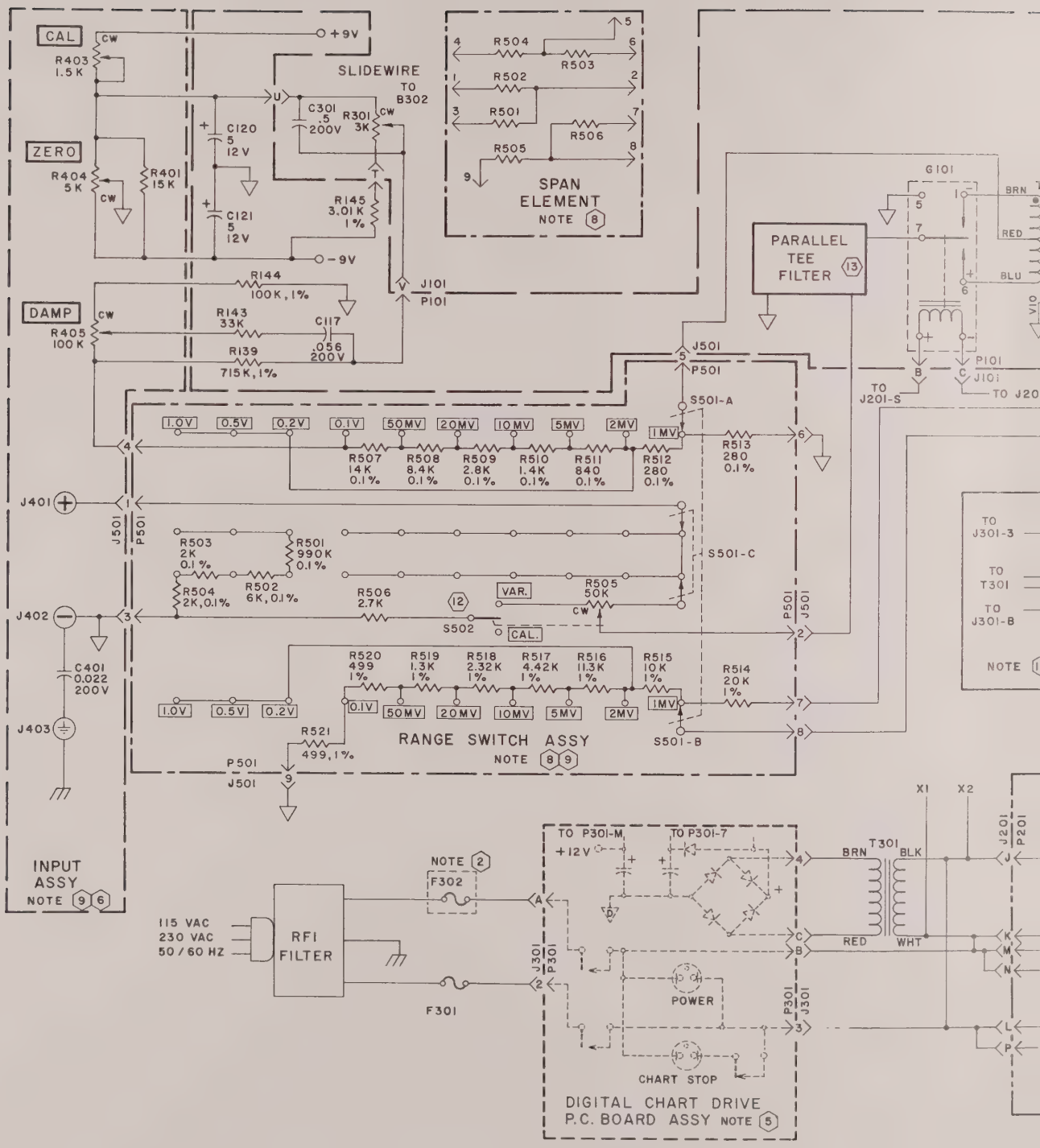
4. TB304 JUMPERS AS FOLLOWS:
   - 4.1 115 V 1 OR 2 CHANNEL - 6 TO 7, 9 TO 10.
   - 4.2 230V 1 CHANNEL - 7 TO 8, 8 TO 9.
   - 4.3 230V 2 CHANNEL - 5 TO 6, 7 TO 8, 8 TO 9.

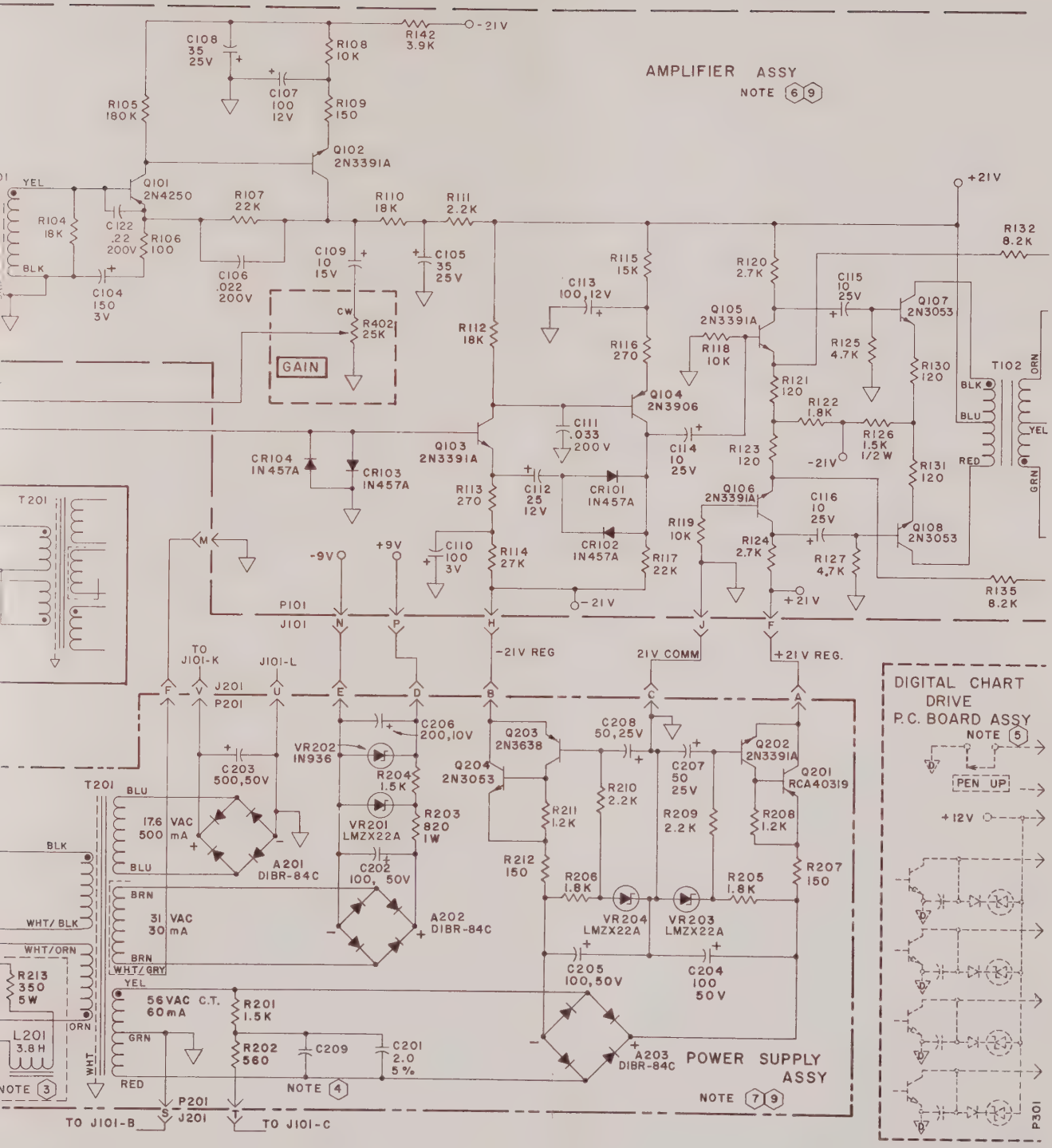
8. S302 USE
7. FOR ASS
6. FOR SCH



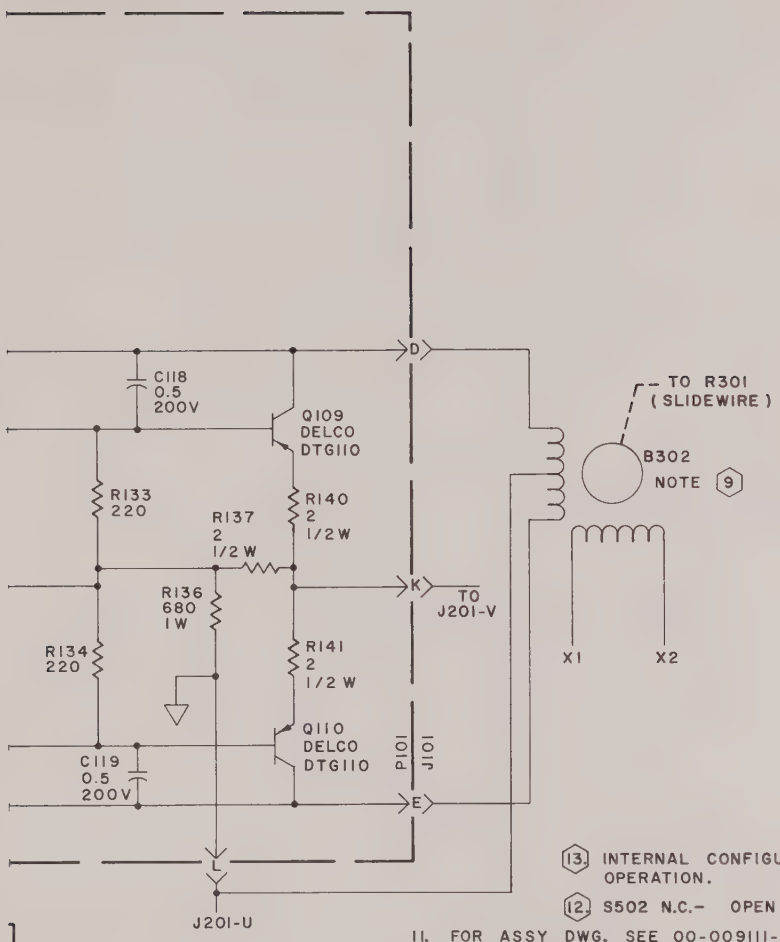
DUAL CHANNEL ONLY.
Y SEE DWG. 00-009111-00.
TIC SEE DWG. 75-000363-00.

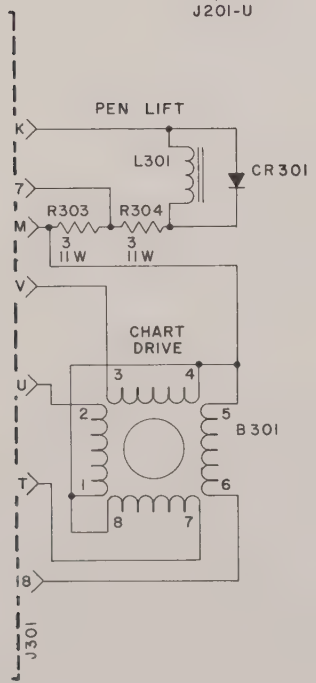
Wiring Diagram
Series G-2500
75-000362-00
Issue 1


CAL
ZERO
DAMP
R403 1.5K
R404 5K
R401 15K
R405 100K
C120 5 12V
C121 5 12V
C301 .5 200V
R301 3K
R145 3.01K 1%
R144 100K, 1%
R143 33K
C117 .056 200V
R139 715K, 1%
+9V
-9V
SLIDEWIRE
TO B302
J101
P101
SPAN ELEMENT NOTE 8
R504
R503
R502
R501
R506
R505
PARALLEL TEE FILTER 13
G101
BRN
RED
BLU
TO J201-S
TO J20
J501
P501
S501-A
S501-B
S501-C
1.0V
0.5V
0.2V
0.1V
50MV
20MV
10MV
5MV
2MV
1MV
R507 14K 0.1%
R508 8.4K 0.1%
R509 2.8K 0.1%
R510 1.4K 0.1%
R511 840 0.1%
R512 280 0.1%
R513 280 0.1%
R514 20K 1%
R515 10K 1%
R516 11.3K 1%
R517 4.42K 1%
R518 2.32K 1%
R519 1.3K 1%
R520 499 1%
R521 499, 1%
J401
J402
J403
R503 2K 0.1%
R501 990K 0.1%
R504 2K, 0.1%
R502 6K, 0.1%
R506 2.7K
12
VAR.
R505 50K
CW
S502
CAL.
C401 0.022 200V
RANGE SWITCH ASSY NOTE 8 9
INPUT ASSY NOTE 9 6
TO J301-3
TO T301
TO J301-B
NOTE 1
115 VAC
230 VAC
50/60 HZ
RFI FILTER
NOTE 2
F302
F301
J301
P301
TO P301-M
TO P301-7
+12V
T301
BRN
BLK
RED
WHT
X1
X2
J201
P201
POWER
CHART STOP
DIGITAL CHART DRIVE P.C. BOARD ASSY NOTE 5



Schematic Diagram
Series G-2500
75-000363-00
(Sheet 1 of 2)
Issue 1

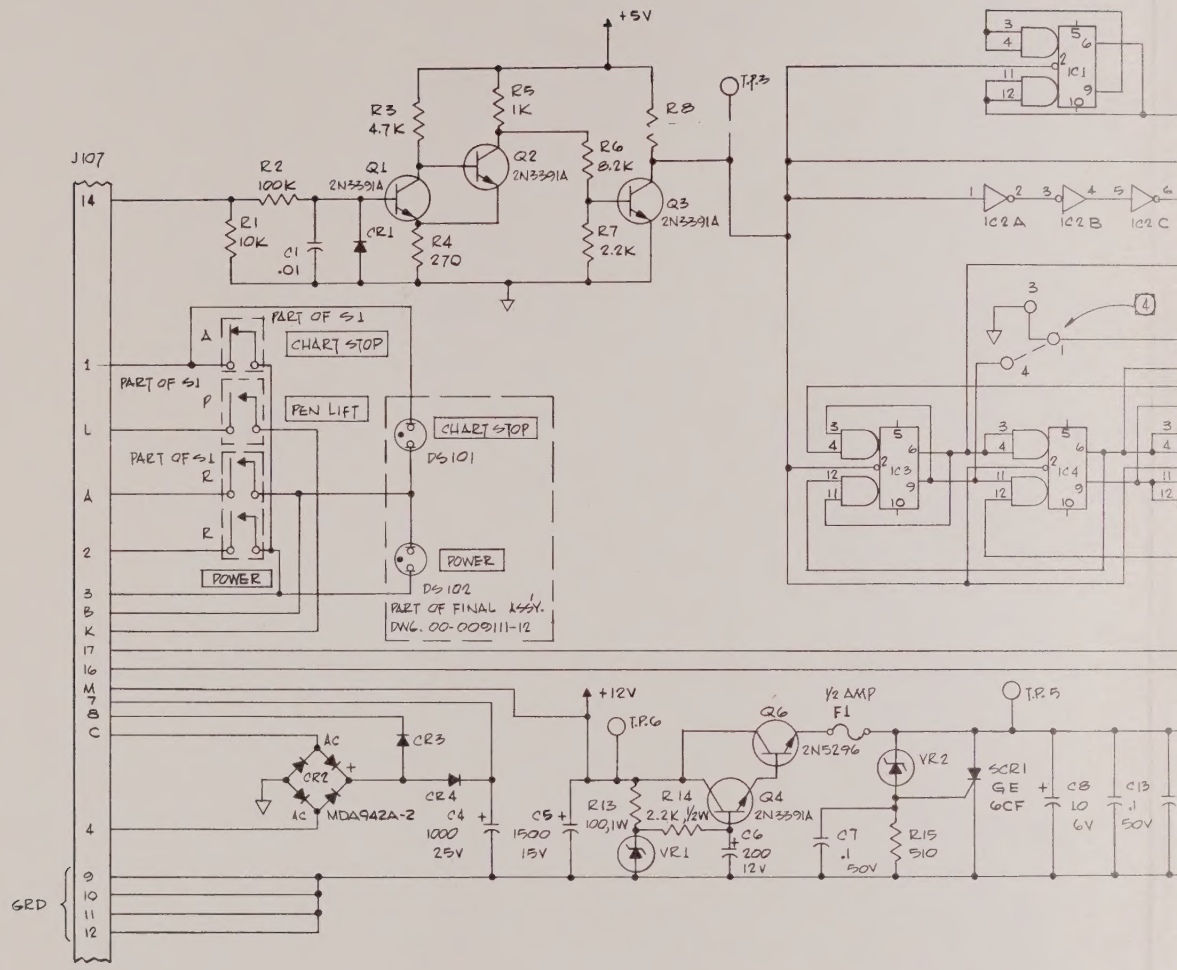




NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL CAPACITORS ARE MEASURED IN MICROFARADS, 20%, 200 V DC. ALL RESISTORS IN OHMS, 1/4 W, 5%.
2. F302 USED ON 230 VAC ONLY.
3. L201 AND R213 USED ON 230 VAC DUAL CHANNEL ONLY.
4. C209 IS 1.0 MFD, 5%, 200V FOR 50 HZ OPERATION, 0.5 MFD, 5%, 200V FOR 60 HZ.
5. DIGITAL CHART DRIVE ASSY SHOWN FOR REFERENCE ONLY. FOR COMPLETE SCHEMATIC SEE DWG. 75-000353-00. FOR ASSY SEE DWG. 02-001416-00.
6. FOR AMPLIFIER / INPUT ASSY DWG. SEE 00-972093-00.
7. FOR POWER SUPPLY ASSY DWG. SEE 02-001474-00.
8. SPAN ELEMENT USED ON FIXED SPAN RECORDERS, RANGE SWITCH USED ON VARIABLE SPAN.
9. SINGLE CHANNEL RECORDER SHOWN. DUAL CHANNEL UNIT SIMILAR WITH IDENTICAL AMPLIFIER, POWER SUPPLY, RANGE SWITCH / SPAN ELEMENT AND INPUT ASSY ADDED.
10. TRANSFORMER CONNECTED AS SHOWN FOR 230 VAC OPERATION.
11. FOR ASSY DWG. SEE 00-009111-00.
12. S502 N.C.- OPEN WHEN R505 FULL CCW ONLY.
13. INTERNAL CONFIGURATION CHANGES FOR 50 OR 60 HZ OPERATION.

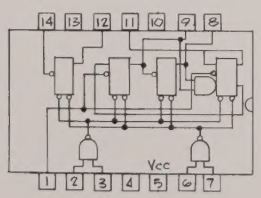
Schematic Diagram
Series G-2500
75-000363-00
(Sheet 2 of 2)
Issue 1



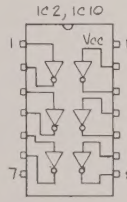
7. VR1 & 2 ARE LMZX6.2A, VR3 THRU VR6 ARE LMZX12.0A.
6. IC VOLTAGES & GROUND CONNECTIONS ARE AS FOLLOWS IC 1 THU IC 6 & IC 10 THRU IC 13: GROUND ON PIN 7, Vcc IC 7 THRU IC 9: GROUND ON PIN 10, Vcc ON PIN 5.
5. SWITCH S1, "B" THRU "L" INTERLOCKED; M & N ALSO INTERLOCKED. (WHEN A SWITCH POSITION IS ACTIVATED
[4] 60 Hz. VERSION AS SHOWN, FOR 50 Hz VERSION REMOVE EXISTING JUMPERS BETWEEN PADS 8 & 9, 2 & 5, 1 & 3 INSTALL JUMPERS SHOWN IN DOTTED LINES BETWEEN PADS 8 & 13, 1 & 4, 6 & 9.
[3] INSTALL JUMPER SHOWN IN DOTTED LINE WHEN EXTERNAL SWITCHING IS NOT REQUIRED.
2. UNLESS OTHERWISE NOTED: ALL RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%; ALL CAPACITANCE VALUES ARE IN ALL DIODES ARE 14-000018-00, ALL TRANSISTORS ARE 2N3643.
1. FOR ASSY DWG SEE 02-001416-00.

NOTE:

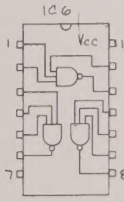
IC7, IC8, IC9



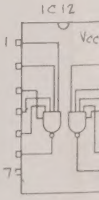
IC2, IC10

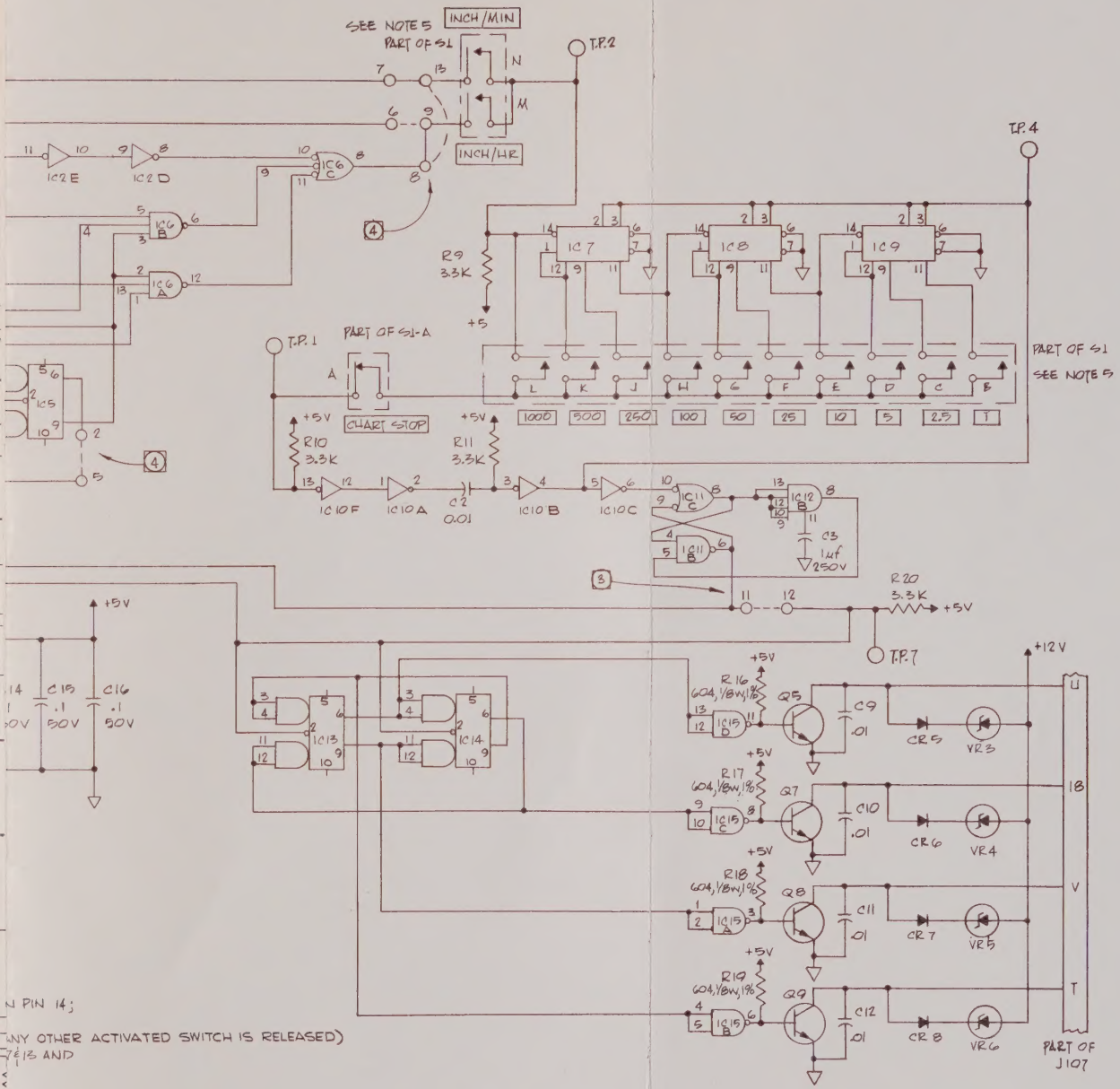


IC6



IC12





Digital Chart Drive Schematic
Series G-2500
75-000353-00
Issue 1

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